PSYCHE

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A SIMPLE STROBOSCOPIC METHOD FOR THE STUDY OF INSECT FLIGHT

BY LEIGH E. CHADWICK

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The methods which have been used for the study of insect wing motion may be reduced for purposes of comparison to six types. Briefly these are (1) the deductive method, (2) the acoustic method, (3) the visual or optical method, (4) the graphic method, (5) the photographic method, and (6) the stroboscopic method. A short discussion of them and of the sort of information they have yielded will be useful in judging the possibilities of the new application of the stroboscopic method outlined below. Further details and references may be found in the works of Prochnow (1924), Weber (1933), Magnan (1934) and Snodgrass (1935).

The deductive method is essentially that of the earlier anatomists. Supplemented by manipulation of dead or anæsthetized specimens it is still useful in studying the more intimate mechanism of the thorax. It cannot be expected to give exact information as to the actual motions of the wings in flight, nor *a fortiori* as to their rate.

The principle employed in the acoustic method is to match the insect's *Flugton* with the tone of a tuning fork or other instrument of known frequency. This method was applied extensively by Landois (1867) for rate determinations, but his results have not agreed too well with those obtained more directly with kymograph or camera. The relation between the pitch of an insect's tone and the frequency of its wing motion is still not completely understood, and in many cases

it appears likely that harmonics may be mistaken for the fundamental. For this reason, and because of difficulties thought to be introduced by the Doppler effect, not much attention has been given to this method by later workers.

The optical method of Wheatstone (1827) was applied by Marey (1868) to the study of wing motion. By gilding areas of the wing he was able to observe its trajectory in living insects held with forceps, and confirmed Pettigrew's (1868) deduction that the wing stroke follows the outline of a figure-8. The type of problem for which this method is suitable is illustrated further by the work of Stellwaag (1916), who was able thus to observe the differential action of the wings in steering. The method cannot be called on, however, for the sort of detail available so abundantly in a photograph, and has the further disadvantage that information gained from it must often pass through a stage of subjective interpretation before it reaches the record. It permits some degree of measurement of the various amplitudes of the wing motion, but affords no data as to rate.

Marey (1868) also introduced the use of the kymograph in the study of wing motion. This instrument gives a permanent non-subjective record, from which it is easy to calculate frequencies, but is limited in other directions. The wing of the insect, used as the recording lever, is of fixed radius, and its motion is complex. If undue friction is to be avoided, only a small fraction of the arc described by the wing tip may be recorded at one time. Insofar as frequency measurements are concerned, the results obtained by Marey and other students who have used the graphic method agree, on the whole, within the limits of normal variation with data derived from other techniques. The distortions bulk larger, however, where it is desired to achieve a true picture of the unhampered motion of the wing. Naturally the kymograph may be used only with fastened and not with freely flying insects.

A third technique introduced by Marey and in the development of which his followers have had a large share is that of high-speed photography. Theoretically this is the most advantageous method for the study of insect flight, but its application is difficult. The high rate at which the wings are moved, 150–250 beats per second being not uncommon

among the Diptera and Hymenoptera, fixes the length of exposure, and the duration between successive exposures for motion pictures, at exceedingly low limits. To obtain adequate illumination at such frequencies becomes a very real problem, which is intensified by the small size of many species. Added to the photographic difficulties are those of posing the often unwilling specimens. Under these conditions, the method proves expensive in time, film and apparatus,—yet the results which it promises serve amply to justify continued efforts toward its perfection. The extent to which the obstacles mentioned have been overcome at present may be gauged by reference to the fine reproductions in Magnan (1934).

With the more evident merits and disadvantages of these several methods in mind, we may proceed to discuss the stroboscopic technique. The stroboscopic principle has been the basis of most of the attempts at high-speed photography, but Oehmichen (1920) appears to have been the only worker who has previously made much use of the stroboscope for the visual study of insect flight. With the stroboscope, cyclic motions may be made to seem to stand still (and to proceed slowly forward or in reverse) no matter what the actual frequency may be. All that is necessary is an intermittent source of light tuned to synchrony (or near synchrony) with the motion to be observed. In Oehmichen's apparatus light was provided by electric discharge across a spark gap or through a Geissler tube. Frequency could be synchronized automatically with that of the wings by an ingenious arrangement which allowed air currents produced by the wing to open a very light key in the primary circuit at a given phase in each beat. If a variable control of frequency was desired, this key was replaced by a rotary interruptor, the speed of which was regulated by a potentiometer. With this apparatus Oehmichen made visual and photographic observations of much interest, but neither his results nor his method have received much attention since their publication.

The recent development of the Edgerton stroboscope (Germeshausen and Edgerton, 1937) should give a new impetus to studies along this line. Earlier stroboscopes have suffered from shortcomings, either in regard to the source of

light, which was not dependable, or in regard to control of the frequency, which was unwieldy because of rotational inertia, etc. No difficulties of this sort are met with in the instrument under discussion, in which the flash-frequency of a neon or other low-pressure-filled bulb is controllable instantly by an adjustable electric oscillator. The instrument as supplied operates on 110 V 60-cycle AC, and gives direct scale readings in RPM over a range of 600–14,400 cycles per minute (10–240 per second). Values above and below these limits may be calculated easily from harmonic relationships. The accuracy is within $\pm 1.0\%$ over the full range.

The motion of an insect's wings is fundamentally a cyclic phenomenon, and may therefore be studied by this means. In theory one may place any flying insect before the instrument and by suitable tuning either "stop" the wings completely at any phase in the cycle or permit the cycle to proceed slowly through its several phases while observations are made. How fully these desired conditions may be attained in practise varies considerably with different insects, but, given appropriate treatment of the specimens, the theoretical expectations may be realized very satisfactorily.

Rates may be determined quickly and easily.

Study of the complex motions of the wings is more exacting. Here results depend partly on the operator's patience, since the problem is largely one of inducing the specimens to fly steadily and for longer intervals. Favorable responses can be had in the majority of cases, and are well worth the effort, for the details of the wing motion are displayed with a clarity that is far beyond that of any photographs so far published.

The most evident disadvantage of the method is that, like other visual techniques, it gives no permanent record beyond the notes of the observer. In respect of rate determinations, this objection is less forceful, since one simply tunes to synchrony with the wing frequency, thus obtaining a single standing image, and reads the figures from the dial. Reference to adjacent harmonics quickly settles any doubt as to whether one has been observing the true fundamental or one of its submultiples.

Because of the natural variation in rate, it is often difficult to retain a standing image over any extended period, though

constant frequency over an interval as long as one minute has been observed not infrequently in *Drosophila*. In determining rates, this is again of no particular disadvantage in most cases, for here the limits of variation are the significant feature and may be measured quite accurately. Where observations of wing motion as such are to be made, however, it is of importance to know whether or not the apparent motion has the same sign as the true motion. For example, the wings of a noctuid moth during the downstroke show a marked upward curvature of the flexible tips. If the stroboscope be tuned to a frequency slightly above that of the wings, there will be a slow apparent motion in reverse of the true motion, and the wing tip will then *seem* to be bent upward during the upstroke. Such incongruities may be less patent in the motions of a smaller or more stiff-winged insect, so that caution is necessary. This is particularly so of insects with a very variable rate, whose true frequency may be now to one side and now to the other of the setting on the dial.

Transient motions, for example those involved in starting or in stopping flight, are beyond the scope of such a method. Here, as in many other instances, the ultimate recourse must be the motion-picture camera.

A further weakness of the instruments obtainable at present is that the intensity of the neon bulb is rather low. This means that specimens must be placed close to the source, and outside illumination cut off or reduced to a minimum. In theory it should be quite possible to observe with stroboscopic light the motions of an insect flying freely in a room; practically this ideal is difficult to attain. Even with completely adequate lighting such methods could not be satisfactory with the smaller species. With larger forms, of the size of *Leucania unipuncta* Haw., for instance, they may be useful, once the essential improvements have been made.

With the cooperation of Professor Edgerton, of the Massachusetts Institute of Technology, the writer has been supplied with additional equipment, including tubes of higher intensity. These give a bluish-white light which is suitable for certain types of photographic work. Photography with the neon tubes is out of the question. Unfortunately the bluish-white light seems to have an inhibitory

effect upon many insects, so that these tubes have not been as useful in the study of free flight as had been hoped. Whether this is due to some peculiarity of the spectrum, or to an effect of flicker at the higher intensities, which is lacking with the neon bulb, has not been determined. Certain moths are sensitive to noise, and respond adversely to the high-voltage crackle from these tubes as well as to the quality of the light. Still it has been possible to take readings on the wing rate of these and other insects flying freely in a room 12′ x 15′, and observations on specimens confined in jars and other containers are often productive. The brighter bulbs have also been used to advantage in studying specimens held in fixed position. At present it is not possible to obtain tubes of this sort which will operate at frequencies much above 100 per second. In connection with the problem of lighting, it may be remarked that, no matter how perfect it may be made, there will always be the natural variation in wing frequency to deal with, as well as the limitation set by what the human eye can observe in a small object traveling rapidly through space.

Where specimens held in fixed position are to be studied, the technique of fastening them is important. A discussion of the problems this introduces would lead beyond the limits of this article, and must be deferred to another occasion.

Finally, one additional limitation of the stroboscopic method should be noted. At rates well below the fusion frequency for the human eye, there is, as might be expected, a disagreeable flicker. This is especially objectionable when one is observing through the binoculars. Fortunately the wing rate of most insects is high enough so that this drawback is of minor consequence. The writer finds observation not uncomfortable at frequencies as low as 20 or 25 per second, where detail, such as motions of parts of the thorax, is to be studied. Direct rate readings are possible down to the limit of 10 per second, or may be taken in higher multiples if this seems preferable.

In concluding this criticism of the stroboscopic method, one may point again to the great advantage of being able to make direct visual observation of the motions of flight, at a rate determined by the observer, and also to the large number of observations that can be made within a limited time.

It is quite practicable to take a series of rate readings on one individual at 10-second intervals. With a series of specimens, where one observer has done all the handling and recording, the interval between readings has been about 40 or 50 seconds; if the recording is done by a second person, rates may be read on several specimens within a minute.

It is felt that a great deal can be added to our knowledge of insect flight by the more extended use of this type of stroboscope. Much that is now conjectural in regard to the motions of the wings can be replaced by fact, easily and at relatively small expense. Even after high-speed photography has reached the state of perfection desired, and the day is not yet, the stroboscope will still have its own field of usefulness. There is need for extensive observation of living specimens under experimental conditions where photography may be neither necessary nor possible. For the photographer himself the stroboscope is a valuable adjunct which permits him to study in advance the rate and type of motion which he is about to attempt to photograph. The various shortcomings and difficulties to which attention has been called above are those which have presented themselves during six months work with this instrument on the problems of insect flight and should serve to indicate the natural limitations of the method.

The application of the stroboscope in the study of wing motion has been simplified by the generous cooperation of Professor H. E. Edgerton of the Massachusetts Institute of Technology. The writer wishes to take this opportunity of acknowledging his assistance and of thanking Professors C. T. Brues and A. C. Redfield, of the Department of Biology, Harvard University, for their encouragement in this work.

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IMMATURE NORTH AMERICAN TRICHOPTERA

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Several keys to the larvæ and two to the pupæ of North American Trichoptera are already available[1] but none of them summarizes recent study of adequate material, and all but one are based either directly or indirectly on tables presented by European workers.

A search for family and subfamily characters in North American caddis larvæ and pupæ has yielded the two keys below. Since the pupal stage is much less completely known than the larval, the key to the former is more artificial than that to the latter, especially with respect to members of the families Odontoceridæ and Sericostomatidæ. To somewhat offset this disadvantage, a very useful list of spur formulæ is appended, summarizing the known information on this character.

[1]1901. Betten, C. in Bull. 47, N. Y. State Mus. pp. 563-564. A larval key compiled from European papers by Klapalek and Struck.
1915. Krafka, J. Jr. in Can. Ent. 46: 217-225. Original keys to larvae, guided by Ulmer's 1909 European work.
1921. Lloyd, J. T. in Bull. 21, Lloyd Lib. (Ent. Ser. 1) p. 15. A slightly modified translation of Ulmer's 1909 key, larvae only.
1921. Lutz, F. E. in Field Book of Insects (Putnam) pp. 58-60. A modification of Betten's 1901 key to larvae.
1925. Comstock, J. H. in Introduction to Entomology (Comstock) p. 560. A modification of Lloyd's 1921 key to larvae.
1926. Essig, E. O. in Insects of Western North America (Macmillan) p. 175. A modification of the key to larvae in Lloyd 1921 and Comstock 1925.
1926. Sibley, C. K. in Bull. 27, Lloyd Lib. (Ent. Ser. 5). An apparently original key to the pupae of species found on the Lloyd-Cornell Reservation, N. Y.
1933. Brues, C. T. & A. L. Melander in Bull. 73, Mus. Comp. Zool. Harvard, pp. 195-197. A modification of Krafka's 1915 key to larvae.
1934. Betten, C. in Bull. 292, N. Y. State Mus. pp. 117-123, the larval key a copy of Krafka's 1915 work, the pupal key from Ulmer's 1909 key.

Caddis larvæ inhabiting movable cases have the head bent downward so that the mandibles are ventral (hypognathous) in position, the long axis of the head at an obtuse or even a right angle with the long axis of the body. Those with a right-angled attachment are said to be *eruciform* larvæ, those with an obtuse angle to be *suberuciform*. Caseless larvæ have the long axis of the head in line with the long axis of the body and the jaws hence at the anterior end of the animal (prognathous). Such larvæ are said to be thysanuriform or *campodeiform*.

Case-bearing larvæ frequently have fleshy tubercles on the sides and notum of the first abdominal segment. These are called *spacing humps*, and serve to keep a passage for respiratory water between the larva and its case. Such larvæ also often have a prominent projection from the prosternum, extending between the front coxæ. This is the *prosternal horn* or prosternal spine.

The head capsule or *epicranium* splits at ecdysis into right and left halves. It bears the articulating surfaces for the mandibles antero-laterally and may or may not meet on the mid-line ventrally, anterior to the neck opening *(occipital foramen)*. In some forms a submentum or *gula* is well developed, the gula being sometimes quadrate, at other times triangular or crescentic. It may keep the epicranial halves entirely apart, extending from the labium to the occipital foramen, or it may separate them only anteriorly, so that the foramen is entirely surrounded by epicranium. A U- or V-shaped emargination in the anterior margin of the epicranium on the mid-dorsal line accommodates the *frons* to which the *labrum* is attached by a flexible membrane. There is no clypeus. The antennae are usually very small.

Many larvæ have a fringe of hairs along the abdominal lateral line, the so-called *"lateral fringe."* The abdomen frequently bears along the dorsal, lateral and ventral surfaces filamentous or branched structures called *gills*, although their respiratory function is doubtful. Around the anus filamentous or sac-like structures are often seen. These are the *rectal gills*, which are seemingly retractible into the rectum. Also apical on the abdomen are the *prolegs*, fleshy structures with claws, used in locomotion. The thoracic appendages are true *legs*, and consist of five segments, a

large *coxa* articulating with the pleurite, a small trochanter (always indistinctly divided), a large *femur*, a *tibia*, and a one-segmented *tarsus* bearing a movable *claw*. Usually the tibia ends in a spur. In Leptoceridæ and some Odontoceridæ, the middle and hind legs have the *femora divided* into two, the proximal half shorter than, or equalling the distal half.

In the pupæ imaginal structures such as antennæ, maxillary and labial palpi, ocelli, tibial spurs, sternal ligulæ and genitalia may be studied, in addition to the labral bristles, gills and anal processes of the pupal skin itself. All females have the *maxillary palpi* 5-segmented, but the males of some families show a reduction in this number. In some families in which both sexes have 5-segmented maxillary palpi, the terminal segment is secondarily annulated. *Labial palpi* are always 3-segmented. There are 3 *ocelli* present or none are found. The fore tibiæ may have as many as 3 spurs, the middle and hind tibiæ as many as 4 spurs. When no more than 2 spurs are present, they are terminal. A third or fourth spur is added part way up the tibia. The number of spurs is indicated by a *spur formula*. Thus 1-3-4 indicates that the fore tibia bears one (terminal) spur, the middle tibia a pair of terminal and a subapical spur(s), the hind tibia a pair of terminal and a pair of subapical spurs. The *labral bristles* are used to clean the gratings which allow entrance of water into the pupal case. The *gills* are much like those of the larva but often differ in number and arrangement. The *anal* processes are extensions of the pupal skin which cover the cerci and genitalia and often bear bristles for cleaning the grating which allows exit of water from the pupal case.

Key to North American Caddis Larvae

1. Abdomen very much wider than thorax; very minute species with all three thoracic segments heavily sclerotized above, living in portable silken cases which are much larger than the larvæ: *Hydroptilidæ*

   Abdomen not much wider than thorax; much larger species, never with all three thoracic nota heavily sclerotized above in any case-bearing species, the cases when present not much larger than the larvæ 2

2. Last abdominal segment never with a sclerotized shield above; body campodeiform, the head held straight forward, forming a continuation of the long axis of the body; abdomen of nine segments, the prolegs distinct from one another; no tubercle on first abdominal segment; no prosternal horn; no lateral line fringe; abdomen depressed, the sutures between the segments deeply impressed; gills usually absent; rectal gill structures generally present but not always everted; larvæ not constructing a movable case 3

   Last abdominal segment usually with a sclerotized shield above—if lacking it, the body eruciform (hypognathous) and the larva living in a movable case (Leptoceridæ); gills usually present 10

3. Labrum soft, whitish, retractile under edge of frons 4

   Labrum wholly sclerotized 5

4. Mandible with a prominent tooth at middle of medial margin; frons with a deep asymmetric emargination: ..... *Philopotamidæ*, subfamily *Chimarrhinæ*

   Mandible with no such prominent tooth; frons scarcely emarginate: ..... *Philopotamidæ*, subfamily *Philopotaminæ*

5. Claws of legs long and slender, nearly straight, with only one basal spur; penultimate segment of maxillary palpus very long: ..... *Psychomyiidæ*, subfamily *Polycentropodinæ*

   Claws of legs short, stout, curved; penultimate segment of maxillary palpi not especially long 6

6. Gills absent; only two bristles on convex side of mandibles 7

   Gills present; numerous bristles on convex outer side of mandibles; all three thoracic nota sclerotized 8

7. Only prothorax sclerotized dorsally: ..... *Psychomyiidæ*, subfamily *Psychomyiinæ*

   All three thoracic nota sclerotized: ..... *Psychomyiidæ*, subfamily *Ecnominæ*

8. Gula an elongate, rectangular plate separating epicranial halves completely; all gill filaments in clus-

ters arising from the ends of stalks, somewhat like the tentacles of Hydra; large forms: .... *Hydropsychidæ*, subfamily *Arctopsychinæ*

Gula triangular, never reaching hind margin of head, the epicranial halves contiguous for some distance; gill filaments arising from the side as well as the end of the stalk, more comb-like 9

9. Dorsal surface of head flattened, forming a broad disc, enclosed by a strong carina which crosses the frons near its apex, setting off a small triangle; mandibles with broad, blunt teeth on whole inner margin, the interspaces broad and deep: .... *Hydropsychidæ*, subfamily *Macronematinæ*

Dorsal surface of the head flattened, but with no carina defining its limits; mandibles with sharp teeth apically: ... *Hydropsychidæ*, subfamily *Hydropsychinæ*

10. Body campodeiform, the abdomen depressed; larvæ never constructing a movable case though sometimes building a fixed shelter 11

Body eruciform or suberuciform, the head bent downwards at an angle to the rest of the body; abdomen cylindrical, the sutures between the segments usually feebly impressed; gills usually present; larvæ always living in a movable, tubular shelter 12

11. Prolegs very well developed, entirely separate from each other; proleg claws long and slender, without teeth on convex surface; accessory claws sometimes present at sides of main proleg claws; maxillary lobes long and slender: .... *Rhyacophilidæ*, subfamily *Rhyacophilinæ*

Prolegs short, the basal segments wholly sclerotized and fused to the ninth abdominal segment in a nearly vertical position; proleg claws very short, with small teeth on the convex side; maxillary lobes short and broad; construction of a fixed shelter in late larval life is usual: .... *Rhyacophilidæ*, subfamily *Glossosomatinæ*

12. Prosternum with a horn or spine projecting downwards between the front coxæ 13

No such prosternal horn 15

13. Body suberuciform; lateral gills on segments 2 to 7 usually pubescent with black hairs; mesonotum generally soft like metanotum, rarely with two small sclerotized plates; abdominal constrictions well marked: ..... *Phryganeidæ*

Body eruciform; lateral gills on segments 2 to 7 never pubescent with black hairs; mesonotum generally entirely sclerotized, sometimes only with small plates, rarely completely soft 14

14. Mesonotum entirely sclerotized; metanotum with three pairs of plates; mesothoracic legs stouter and longer than hind legs: ..... *Limnephilidæ*

Mesonotum not entirely sclerotized; metanotum usually entirely soft; middle legs not longer than hind legs: A few *Sericostomatidæ* (Goerinæ & Lepidostomatinæ)

15. Femora of middle and hind legs divided into a shorter basal and a longer apical piece; right mandibles without inner bristles; no accessory bristles on back of mandibles: 16

Femora not divided 17

16. Lateral line well developed 17

Lateral line little developed or absent: ..... *Leptoceridæ*

17. Lateral line well developed, the 8th segment never with only sclerotized points representing the line; labrum with a transverse row of many stout bristles before the middle, or if lacking these, then much longer than broad: ..... *Odontoceridæ*

Lateral line very faint, incomplete or absent, its place sometimes occupied on some segments by sclerotized points; labrum neither with a transverse row of bristles nor longer than broad 18

18. Antennæ rudimentary; pronotum sclerotized, mesonotum never more than partially sclerotized: ..... *Sericostomatidæ*

Antennæ large, the basal segment broad, 2nd more slender and tipped with a fine bristle; pro- and mesonotum both sclerotized 19

19. Distal spurs of fore and middle tibiæ not on prominences; hind legs with normal claws; cases curved tubes, never broad: ..... *Beræidæ*

Distal spurs of fore and middle tibiæ on prominences; claws of hind legs abnormal; cases of sand, broadly shield-shaped like a turtle shell, except those of very young larvæ which have straight sand tubes, often with bits of mollusk shells: ..... *Molannidæ*

KEY TO NORTH AMERICAN CADDIS PUPAE

1. Pupæ very small (not more than 5 mm. long, usually less than 3.5 mm.), with very short thick antennæ; maxillary palpi 5-segmented in both sexes; cases mostly of silk only or of silk covered with very fine sand, the cases flat or thickest in the middle, usually attached at each end by circular discs of silk: ..... *Hydroptilidæ*

Pupæ usually larger, the antennæ nearly as long as the body, not especially thickened; maxillary palpi sometimes 3- or 4-segmented in the male; cases never as above 2

2. Lacking both ocelli and a complete tubular case 3

Either ocelli or a complete tubular case or both present 5

3. Gills absent: ..... *Psychomyiidæ*, subfamily *Psychomyiinæ*

Gills present 4

4. Spurs 3-4-4; anal processes large, blunt, not long; cases made of pieces of leaves or small sand grains, the ventral side of silk only (in Phylocentropus the case is a long, branched tube of sand with only a turret projecting; in Neureclipsis the case is a trumpet-shaped net); ..... *Psychomyiidæ*, subfamily *Polycentropodinæ*

Spurs 2-4-4 or fore tibiæ with one or no spur; anal processes long and heavily sclerotized, with many bristles: ..... *Hydropsychidæ*

5. Case complete, the pupa never in an inner silken cocoon; gills often present; anal processes often long,

rod-like and strongly sclerotized; legs with or without claws 9

Case incomplete, the pupa in an inner silken cocoon; gills absent; no long or rod-like or strongly sclerotized anal processes; legs with good claws 6

6. Inner silken cocoon spindle-shaped like a zeppelin or a fly puparium, attached to the case only at its posterior end; case barn-shaped, usually of pebbles; 5th segment of maxillary palpi not annulated 7

Inner silken cocoon either not complete or fused to case wall near its equator; when incomplete, the anterior end lacking, the posterior end much as in Rhyacophilinæ; 5th segment of maxillary palpi long, curved and distinctly annulated 8

7. Spurs 2-4-4: *Rhyacophilidæ*, subfamilies *Glossosomatinæ* & *Hydrobiosinæ*

Spurs 3-4-4: *Rhyacophilidæ*, subfamily *Rhyacophilinæ*

8. Spurs 2-4-4: *Philopotamidæ*, subfamily *Philopotaminæ*

Spurs 1-4-4: *Philopotamidæ*, subfamily *Chimarrhinæ*

9. Ocelli present 10

Ocelli absent 12

10. Posterior margin of 1st abdominal tergite produced caudad in a distinct median process extending over base of 2nd segment; mandibles with a prominence from which the bristles arise; anal processes flat, somewhat rhombic, with 4 long bristles at the end; spurs 2-4-4; male maxillary palpi 4-segmented: ..... *Phryganeidæ*

Posterior margin of 1st abdominal tergite not produced caudad but with a saddle-shaped prominence, laterally with short spines or with only two lateral tubercles set with numerous hairs or denticles; mandibles with no such prominence; never more than one protibial spur; male maxillary palpi 3-segmented; anal processes long, more slender 11

11. Labrum semicircular, anteriorly emarginate, the dorsal surface elevated, with a transverse furrow back of its mid line; spurs 1-1-1, 1-2-2, 1-2-3, 1-2-4, 1-3-3 or in most, 1-3-4: ..... *Limnephilidæ*

Labrum roughly rectangular, the anterior margin formed of 3 curves, in each of the two emarginations of which is a fine bristle; 5 longer bristles with curved tips vertically on either side of labrum; spurs 1-2-4 (Pharula) or 1-3-4 (Neothremma): ..... *Sericostomatidæ*, subfamily *Georinæ* in part

12. Antennæ very long, the outer part wound around the abdominal apex 13

Antennæ scarcely longer than body, the ends never wound as above 14

13. Two mesotibial spurs; mouthparts so placed that the pupal mandibles point upwards: ..... *Leptoceridæ*

Four mesotibial spurs; mouthparts normal or as above: ..... some *Odontoceridæ*

14. Spurs 2-2-2 (Micrasema) or 2-3-2 or 2-3-3 (Brachycentrus); labrum obtusely triangular to semicircular; maxillary palpi shorter than or but little longer than labial palpi, never stouter: ..... *Sericostomatidæ*, subfamily *Brachycentrinæ*

Spurs not as above 15

15. Case shaped like a snail shell, coiled in a flat spiral, made of sand grains of small size: ..... *Sericostomatidæ*, subfamily *Helicopsychinæ*

Case never of this form 16

16. Less than four mesotibial spurs 17

Four mesotibial spurs 18

17. Body length not less than 5 mm.; robust species: ..... *Sericostomatidæ*, subfamily *Sericostomatinæ*

Body length not over 4 mm.; slender, small species: ..... *Beræidæ*

18. Less than 4 metatibial spurs: ..... some *Odontoceridæ*

Four metatibial spurs, the formula 2-4-4 19

19. Anal processes lobate: ..... *Sericostomatidæ*, subfamily *Lepidostomatinæ*

Anal processes rod-like 20

20. Case of sand, flattened dorso-ventrally and with lateral flanges, closed by discs of silk at the ends, that at the posterior end having a vertical slit, that at the anterior end a horizontal slit: ..... *Molannidæ*

Case not as above, and differently closed 21

21. Case of stones with ballast rocks at the side, straight, never curved: .... *Sericostomatidæ*, subfamily *Goerinæ* in part

Not as above; case with a definite curvature: .... some *Odontoceridæ*

In families Hydropsychidæ (with subfamilies Hydropsychinæ, Arctopsychinæ and Macronematinæ), Psychomyiidæ (with subfamilies Psychomyiinæ, Polycentropodinæ and Ecnominæ) and Philopotamidæ (with subfamilies Philopotaminæ and Chimarrhinæ), the 5th segment of the maxillary palpi is secondarily segmented in the pupa and adult. In Leptoceridæ it is long and slender and often curved but never segmented. In males of Phryganeidæ, the fifth segment is lacking, so that the maxillary palpi are 4-segmented; in males of Limnephilidæ (with subfamilies Apataniinæ and Limnephilinæ) and Sericostomatidæ (with subfamilies Brachycentrinæ, Helicopsychinæ, Lepidostomatinæ, Goerinæ and Sericostomatinæ) the 4th and 5th segments are lacking so that the palpi are 3-segmented. The females of these families and both sexes of families Hydroptilidæ, Rhyacophilidæ (with subfamilies Rhyacophilinæ, Hydrobiosinæ, Glossosomatinæ), Beræidæ, Molannidæ and Odontoceridæ (with subfamilies Odontocerinæ and Calamoceratinæ) have five segments to the maxillary palpi. In all Limnephilidæ, Philopotamidæ, Phryganeidæ, Rhyacophilidæ, two genera of Sericostomatidæ (Thremma and Neothremma of Goerinæ), and in six genera of Hydroptilidæ (Agraylea, Allotrichia, Ithytrichia, Neotrichia, Oxyethira, and Polytrichia) there are ocelli, but elsewhere they are lacking.

SPUR FORMULAE OF NORTH AMERICAN TRICHOPTERA

Formula	*Family*	*Genera Concerned*
0-2-2	Leptoceridæ	Leptocella, Leptocerus, Setodina, Ymymia
0-2-3	Hydroptilidæ	Neotrichia
0-2-4	Hydroptilidæ	Hydroptila
0-3-4	Hydroptilidæ	Agraylea, Allotrichia, Ithytrichia, Orthotrichia and Polytrichia

Formula	*Family*	*Genera Concerned*
0-4-4	Hydropsychidæ	sometimes Hydropsyche
	Rhyacophilidæ	Protoptila
1-1-1	Limnephilidæ	Glyphopsyche (areolatus)
1-2-2	Leptoceridæ	Œcetis, Triaenodes, Ylodes
	Limnephilidæ	Apatidea (nigra), Chilostigma, Glyphopsyche (bellus, canadensis, irroratus, pritus), Homophylax (nevadensis), Ironoquia, Neophylax (fuscus), Stenophylax (subfasciatus), Zaporota
1-2-3	Limnephilidæ	Anabolina (litha, assimilis), Neophylax (ornatus)
1-2-4	Limnephilidæ	Anisogamus (antennatus), Apatidea (all but nigra), Ecclisomyia (all but simulata)
1-3-3	Limnephilidæ	Acronopsyche, Drusinus, Glyphopsyche (ullus), Halesochila, Oligophlebodes, Platycentropus, Stenophylax (circularis, dan, guttifer)
1-3-4	Limnephilidæ	all genera and species not indicated above
	Sericostomatidæ	Neothremma
1-4-4	Hydropsychidæ	sometimes Hydropsyche
	Philopotamidæ	Chimarrhinæ
	Sericostomatidæ	Pharula
2-2-2	Leptoceridæ	Athripsodes, Mystacides
	Sericostomatidæ	Micrasema
2-2-4	Beræidæ	all
	Sericostomatidæ	Helicopsyche, Sericostomatinæ
2-3-2	Sericostomatidæ	some Brachycentrus
2-3-3	Sericostomatidæ	some Brachycentrus
2-4-2	Odontoceridæ	some Marilia, some Heteroplectron
2-4-3	Odontoceridæ	some Ganonema, some Notiomyia
2-4-4	Hydropsychidæ	Arctopsychinæ, Hydropsychinæ except some Hydropsyche
	Molannidæ	all
	Odontoceridæ	some Ganonema, some Notiomyia, some Marilia, some Heteroplectron, all Namamyia, all Nerophilus
	Philopotamidæ	Philopotaminæ
	Phryganeidæ	all
	Psychomyiidæ	Psychomyiinæ
	Rhyacophilidæ	Glossosomatinæ, Hydrobiosinæ
	Sericostomatidæ	Goera, Pseudogoera, Lepidostomatinæ
3-4-4	Psychomyiidæ	Polycentropodinæ
	Rhyacophilidæ	Rhyacophilinæ

THE MIMETIC RESEMBLANCE OF FLIES OF THE GENUS SYSTROPUS TO WASPS

By Charles T. Brues

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Together with a few relatives the genus Systropus is of very different appearance from the other members of the family Bombyliidæ to which it belongs. The body is extremely elongated and the dense pile that generally covers the body in the other, more or less thick-set bombyliids is so greatly reduced that the flies appear almost bare.

During a recent visit to the Dutch East Indies, I was fortunate in taking with the net two species of this genus on the island of Sumatra. Having previously observed and collected one of our common North American species, *Systropus macer* Loew, I was at once struck by the very different color pattern of its Sumatran relatives. Also the latter appear to mimic entirely different types of wasps, suggesting that two independent lines of evolution have been active in developing widely divergent, but equally fine cases of mimetic resemblance in the two hemispheres. This situation appeared so remarkable, that I attempted to follow it further by an inquiry into the color patterns of the other numerous members of the genus which is known to be almost world-wide in distribution. On account of their striking appearance and easy recognition a great many species have been described by a considerable number of entomologists.

Bezzi, in his taxonomic review of Systropus has already commented on the general color pattern which prevails among the species inhabiting two of the great zoological regions. He refers to the Oriental forms as having the aspect of vespids and the Nearctic ones as ammophiloid, *i.e.*, like the sphecoid genus "Ammophila" now called Sphex by taxonomists. The comparison is particularly apt in the case of the North American species as the resemblance to these digger-wasps is very great. Indeed, when in flight our com-

mon *Systropus macer* Loew may be readily mistaken for a species of "Ammophila", but it has the habit, frequently seen in dipterous mimics of wasps and bees, of resting on the leaves of plants even during the brightest hours of sunshine.

Among the Oriental and Indomalayan species the resemblance to vespid wasps is not nearly so close, but nevertheless very striking. In the case of *Systropus numeratus* de Meijere of which I collected a male at Bangkinan, Sumatra, during May 1937, it would appear that the model is *Stenogaster micans* Sauss.[1] as this wasp was flying very abundantly in the vicinity at the time the Systropus was taken. The two are of approximately the same size, but the gaster of the wasp is much stouter and the yellow markings on the thorax are larger, darker and do not coincide in size or position; likewise the wasp is brilliantly spotted on the sides of the gaster which is not the case in the fly. Nevertheless when alive the close resemblance is unmistakable although it is not borne out by a too critical comparison of the pinned specimens.

Another species, *Systropus varipes* Edwards, collected near Pematangsiantar, Sumatra is much smaller with darker legs and abdomen, and although quite wasp-like, is less conspicuously so and no vespids that resemble it at all closely were observed flying at the same time. Several of the small social species which are there common were present; all of these are much stouter and could not under any circumstances be confused with the Systropus.

In general, the species of Systropus in this part of the world are "vespoid" mainly by reason of a conspicuous spotting of the thorax which is marked with light yellow. Although the pattern varies, the basic arrangement of markings is of one type with permutations in shape and size. The coloration of the abdomen is black, varied with reddish brown or dull yellow, the reddish usually at the base and the yellow on the apical segments or venter.

In the Nearctic "ammophiloid" species the pale spotting of the thorax disappears and the reddish color is restricted to the petiolar basal segments of the abdomen while the

[1]Kindly identified for me by Dr. Jos. Bequaert.

yellowish abdominal markings are lost. This coloration, in combination with the shape of the body produces the really astonishing resemblance between the fly and wasp, since most of our common "Ammophilas" have the conspicuous red basal abdominal marking.

The African species are in general colored like the Nearctic ones with the ferruginous color sometimes extending conspicuously on to the thorax, although pale spotted ones are known also from this continent.

Among the species known from the Neotropical region the thorax may be conspicuously marked with whitish or yellowish or this pale pattern may be almost entirely suppressed. They are thus intermediate between the "vespoid" and "ammophiloid" series.

A Tasmanian species, *S. clavifemoratus* Hardy is of the unspotted type and also one from Madagascar while *S. studyi* Enderlein from South China is said by its describer to resemble *Ammophila atripes.*

If then we consider the species from the several zoological regions together the development of two such divergent mimetic types is not so surprising for each appears to represent a modification of not such very great extent from a somewhat intermediate pattern. As the "ammophiloid" type is more widely distributed, extending even into the Australian region, we may consider the development of conspicuous yellowish spotting as the more recent pattern.

SOME EXTRACTS FROM THE HISTORY OF ENTOMOLOGY IN CHINA

By Gaines Liu

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The following extracts are of historical interest only. They are published here, not in the spirit of questioning the scholarship of those whose work I shall mention, but to render available some of the historical facts to those who might care to have them but who are handicapped by language difficulties. My point can be better explained by a very good instance. In a book, called Chow Li, one of the 13 Classics published long before the Christian era, we find a detailed account of a "Bureau of Entomology" which would be considered well organized even under our modern standard. Yet China is not even mentioned by Dr. L. O. Howard, one of the best known and the most respected entomologists of the world today, in his "History of Applied Entomology". It is very plain in this case that the whole trouble is due to an inability to consult Chinese literature. Later on I shall publish a note on this ancient "Bureau of Entomology". For the present I should like to add some information to supplement the following books, namely:

1. The Biological Control of Insects, by H. L. Sweetman, 1936.
2. The Insect Singers, by J. G. Myers, 1929.
3. Entomology, by J. A. Folsom and R. A. Wardle, 1934.

1. *The Biological Control of Insects — Earliest Record ca. 889-903.*

This book appeared in 1936. I ordered it last year when I was in China but the war came earlier than the book, and it was only lately that I had the pleasure of making the ac-

quaintance of this excellent work. On the first page, Dr. Sweetman writes as follows:

"The first written record we have of the movement of beneficial insects is that of Forskål (1775). He states that the date palms in Arabia were attacked by ants, which often destroyed the trees. The growers introduced colonies of predatory ants annually from the mountains and these controlled the pest species."

Dr. Sweetman is well aware of the practice of using ants in pest control in that part of the world, for immediately he writes that "the use of ants for the protection of orchards from insect pests is a practice of long standing in various Asiatic countries, and is still employed today". To this, based upon my personal field data, I quite agree and I can add a few more uses of the ants and some other forms of biological control of insects as practiced in my country. But what concerns us now is the "first written record". The following is a translation of a Chinese record.

"There are many kinds of ants in Lingnan (South China). Sometimes one finds that the ants are carried in a bag and sold on the market. The ants are yellow with long legs, larger than ordinary ants and live in a nest made from leaves and twigs. They are bought for the protection of the orange for it is said that without these ants most of these fruits would be wormy."

This record is contained in a book called Ling Pio Lu Yi or Wonders from South China by Liu Shun. There is no way to tell when this book was published. We know, however, that the author served as an army officer in Kwangtung during the reign of Tsao Chung of Tang (889-903) and the time must have been near the end of the 9th or the beginning of the 10th century. The same fact was mentioned in "Book on Tree Planting" by Yu Tsung Ben, a writer from the Yuan Dynasty (1280-1368). Thus Dr. Sweetman will be glad to know that the written records of insect control really go back much earlier. The ants in question were determined, according to the correspondence I have had with Prof. W. E. Hoffmann of Lingnan University, Canton, as *Œcophylla smaragdina* Fab. and were determined probably by the late Professor Wheeler. Today in Canton nests of these ants may be bought for about one silver dollar each.

2. *The Insect Singers — "Chu Ki" is Lycorma not Huechys.*

Although this book was published in 1929, I had not seen it until recently when I came to work on the cicadas I brought from China. Dr. Myers, the author, has given us a handy and readable book on the natural history of these insects. What interests me particularly are those occasions where he speaks on cicadas in China. Here it gives me the impression that, being unable to get at the original sources and consequently relying on what others have to say, Dr. Myers, in some cases, unfortunately subscribed as an innocent victim to those mistakes committed by others.

For instance on page 3 he states, "the mention of cicadas apparently does not occur until the authoritative edition, the Pen Ts'ao Kang Mu, of A.D. 1578." The author gives one the impression that the cicadas were not mentioned until 1578 while what he really means, if I interpret correctly, is that they were not mentioned in the Pen Ts'ao. In either case, however, if one is able to read Chinese he will find that this is not correct. He will discover, for instance, many references to these insects both in the Li Chi or Book of Rites and the Shih Ching or Book of Odes as these two Classics are respectively known in English. This would mean that the earliest mention occurs at least not later than 500 B.C. because these two Classics were connected in one way or another with Confucius (551-479 B.C.). In short, Dr. Myers has been entirely deceived by the Japanese version.

On page 23, Dr. Myers writes: "the cicada itself was labelled Tchen, while the nymph—the tettiometra or cicada mother, of the Greek—Tchen touy, i.e. the cicada with a skin which falls like that of a serpent." Here we have another mistake that can easily be rectified if one knows Chinese. Tchen touy is the shed skin. How it came to be interpreted as "nymph" is abstruse because "touy" means shed and the shed skin of cicada is the form generally mentioned as a drug in the Chinese pharmacopoeia.

That Chu ki is a Lycorma (*L. delicatula* White), a fulgorid common in north China, not *Huechys sanguinea* De Geer, has never been suspected ever since the day when Amyot created the genus Huechys in 1836. It was fully accepted

by Distant in his Monograph of Oriental Cicadidae (1892) and Dr. Myers of course could not avoid the pitfall. I know that chu ki is Lycorma but I had not associated chu ki with Huechys until I read Myers' book (p. 22), although I have always tried to identify Huechys in Chinese ever since I learned from Distant that this insect is employed by the Chinese as a drug. Now it is clear that Huechys is a direct romanization of the Chinese term chu ki.

There are several ways to prove that chu ki is *L. delicatula* and not *Huechys sanguinea*. "Ki" means a "fowl" and the general form of a Lycorma resembles a fowl while the form of a Huechys does not. On the other hand, Huechys is a southern species, and becomes rare as we approach the Yangtze valley. Among the large number of specimens collected, I have only a single specimen from Wuchang and another one from Ichang (two new records for this species) while all the old specimens in the Harvard collection came from south China. The case with Lycorma seems to be just reverse. Although *delicatula* is known as far south as India, it is not so common in the south as in the north, although the south has its own species. Now all the writers of the Chinese Pen Ts'ao were people from the north. It seems to be more reasonable to assume that the insect in question is a northern species instead of a southern one. But the best proof is found in the description of chu ki as it was given by various medical men and for this I submit the following translation.

"These insects are very common in Honan. They look like a moth but with the abdomen larger and the head and the legs blackish. There are two pairs of wings, the outer pair (tegmina) is grey while the inner pair (wings) is deep red, decorated with all five colors"—from Pen Ts'ao Yen Yi by Kio Chung Pi (1111–1116).[1]

"The chu are the ill-smelling Ailanthus trees. The outer wings of the insects (chu ki) are greyish yellow while the inner ones are decorated with all five colors. They generally line up on the tree and by the late fall, deposit their eggs on the bark. The nymph has six legs, with wings (?) doubled and black and the head depressed and truncated in front."—From Pen Ts'ao Kang Mu by Li Shih Chen (1578).

[1]This is the period with which the name of the author is connected.

The "greyish yellow" is very accurate for those specimens I have from Peiping. From these descriptions, it is evident that chu ki is Lycorma and not Huechys.[2] Huechys, the black cicada with a red head, is called "Er", according to Fang Yen, another Chinese Classic appearing long before the Christian era.

In closing I have one other statement to make for those who are interested in biological problems in ancient China. Based upon my personal experience, obtained in preparing a "History of Entomology in China", a work encouraged by Professor C. T. Brues and Dr. G. Sarton, I have found that the earlier Chinese as a whole were quite vague in their expression. Exactly the same term may mean entirely different things to different authors and sometimes it is very difficult to distinguish them unless one has as a general background some knowledge of the fauna and flora of the region whence the author came. Thus it is not even safe to trust the translation of those who know Chinese unless they are duly qualified from a biological standpoint.

3. *Entomology — Fireflies as Imperial Entertainment in China.*

The following paragraph from Folsom and Wardle, page 521, is very interesting to me.

"Annually the people of Gifu collect many thousands of fireflies which are sent to Tokio and on a certain night are liberated for the enjoyment of the emperor."

This paragraph is interesting to me because it reminds me of the following story about one of the romantic emperors of China.

"In the 12th year of Da Yeh (616), emperor Yang visited the Ching Hua Palace. Bushels of fireflies were collected by imperial order. In the evening, the Emperor and his courtiers went up the mountain. The fireflies were then released and the whole valley became immediately enlivened with the sparklings of these insects."—Sui Shu or Annals of the Dynasty of Sui.

[2]For detailed description of these two insects, see page 157 (*Huechys sanguinea* De Geer) and page 207 (*Lycorma delicatula* White) in Distant, Fauna British India, Rhynchota, Vol. 3, 1906.

Whether the Japanese custom was introduced from China, we do not know. Japan did send a large number of students to China during the Tang Dynasty (618-907). The fireflies are still one of the best evening entertainments the Chinese children have today. Mothers are generally requested by their children to save their empty egg-shells in which the youngsters house their catch and watch the flashing in the dark when they go to bed.

FURTHER NOTES ON CANNIBALISM AMONG LARVÆ

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In a previous communication (Dethier, 1937) most of the reported cases of cannibalism among lepidopterous larvæ were discussed. Hunger and crowding, with thirst as a contributing cause were found to be the prime factors inducing this anomalous diet. This confirms the conclusions of Hering (1926) whose book was previously unavailable to the writer. The present notes offer further explanatory data pertaining to hunger and crowding as causes of a meat diet. The effects of such a diet and the ability of a phytophagous larva to survive on one are considered. Additional cases are also cited.

I

In an effort to understand more fully the various causes initiating cannibalism and the carnivorous habit in general among lepidopterous larvæ the following experiments were designed.

Two final instar larvæ of *Estigmene acrea* Drury and one last instar larva of *Isia isabella* A. & S. were placed in a dry jar approximately twenty inches in volume. Also placed in the jar were one pupating *E. acrea* larva from which the cocoon had been removed, a smaller arctiid in similar condition, and one freshly killed *I. isabella* larva which had been slit open longitudinally. The experimental animals had neither eaten nor drunk for four days. It was observed that they crawled ceaselessly around the bottom of the container exploring the surface with their antennæ and mouthparts. Some dry fæces when encountered were nibbled at slightly. No unusual behavior occurred until the slit carcass was encountered. Here the live animals immediately sucked up the body fluids. After a period of five minutes all three

experimentals were eating the tissues of the exposed larva. Next a decapitated *Encoptolophus sordidus* Burm. was placed in the jar. Its metathoracic legs were removed to prevent kicking. The grasshopper was investigated by the larvæ but no attack made upon it; however, when the carcass was slit open, the larvæ that chanced upon it started feeding almost immediately. The flesh, the eggs contained within the abdomen, and as much of the cuticle as was not too heavily sclerotized were eaten. At this stage the small pupating arctiid was also eaten by the *I. isabella.*

It can be seen from these observations that larvæ are more readily attacked and eaten when their tissues are exposed. It is to be expected that caterpillars would be more attracted to exposed tissues because there is a more concentrated odor arising from them than from an insect completely sheathed in cuticle. Also, there is no stimulation of the mouthparts by an unmutilated carcass. On the other hand, body juices exposed to the air may stimulate the mouthparts directly. Further there is the possibility that larvæ partaking of body juices are prompted to do so by thirst. An unmutilated carcass is attacked only when the larvæ reach such a degree of starvation that they bite frequently at near-by objects.

In order to ascertain the exact series of events occurring when an animal with cannibalistic or carnivorous tendencies approaches another larva, a single live naked noctuid larva was placed in the jar with one *E. acrea.* In the limited area the two frequently encountered each other. The *E. acrea* had reached the stage in which it bit at all objects encountered. When it endeavored to take several bites of the noctuid, however, the latter thrashed about vigorously. Although the arctiid stabbed viciously at its intended victim several times, it finally withdrew. The noctuid's cuticle had not been pierced. On numerous occasions the same process was repeated. Finally the noctuid was rendered more or less quiescent by the buffeting of the more active and aggressive arctiid. In this quiescent state, more or less bathed in its own regurgitated juices and those of its attacker, the noctuid was eaten. Undoubtedly this procedure takes place in most instances when one live insect is eaten by another. The higher percentage of cannibalism noted under crowded

conditions (Dethier, 1937) may be explained by the fact that chance meetings are more frequent. When similar conditions were reproduced in a cage twelve by sixteen inches, both animals eventually died of starvation.

While experiments with mutilated animals indicate that thirst may be one factor in inducing cannibalism, the following experiments demonstrate that hunger by itself is an important factor.

One *E. acrea* was kept in a moist atmosphere, given its fill of water, and presented with every opportunity to continue drinking. When given a mutilated larva of the same species the experimental animal began feeding almost immediately. Repetitions of this experiment prove that hunger as distinct from thirst is one factor in inducing a carnivorous diet.

The experimental animals never chose a diet of meat in preference to plants. Plant food was always accepted even after the larvæ had gorged themselves with meat. In three hours a single *E. acrea* consumed one *E. sordidus*, another consumed one entire *Gryllus assimilis* Fab., and an *I. isabella* consumed one full-grown larva of *Vanessa virginiensis* Drury. These three arctiids pupated and produced normal adults.

With regard, therefore, to the rôle played by hunger and crowding in causing cannibalism the following conclusions seem justified: First, the degree of hunger is of considerable importance. Larvæ in the initial stages of hunger are not readily induced to eat flesh unless stimulated probably by the odor of the body fluids and more certainly by direct contact with them. Larvæ in the final stages of starvation yet still active enough to crawl about do not require such an intense stimulation. Since animals in this condition habitually nibble at near-by objects, they eventually bite through the integument of an intact carcass or a quiescent animal. At this juncture they too are stimulated by the flesh within. An exceedingly active victim is not actually eaten till it has been rendered more or less quiescent although it may still be capable of considerable movement. Second, crowding facilitates the initiation of the events already mentioned as caused by hunger. In addition crowding induces attacks not prompted by hunger (Balduf, 1931; Dethier, 1937).

II

It was observed that relatively large blocks of tissue were present in the fæces of these carnivorous larvæ. In order to facilitate the examination of these tissues to determine what benefit the larvæ were deriving from their diet the fæces were preserved in alcohol, sectioned in paraffin, and stained with Delafield's hematoxylin and eosin.

Examination revealed that the tracheae as well as all other chitinous structures had passed through the alimentary canal completely untouched. This was to be expected since the occurrence of an enzyme acting upon chitin is very limited (Uvarov, 1928). Epithelium had been completely broken down. Relatively large blocks of muscle tissue were present in the fæces. These were recognizable as such; but digestion had been more or less complete, nothing remaining but a faint indication of the muscle fibers. No conclusion could be drawn concerning the fate of fat due to the histological procedure employed. Plant material from the gut of the victim was also present in the fæces. Serial sections revealed that cell walls in the majority of cases were intact although the entire contents had been removed. This is in accord with Biedermann's (1919) contention that all the active components of the digestive juice can diffuse through cell membranes.

In order to throw further light upon the situation, larvæ were tested for the presence of various digestive enzymes. Tests were adapted from Swingle's (1925), Wigglesworth's (1928), Cole's (1928), and Feigl's (1937) techniques. No attempt was made to conduct a differential analysis. Invertase and maltase were present. Neither lipase, lactase, nor amylase were detected. Amylase had been found occurring quite commonly, however (Dirks, 1922; Straus, 1909; Biedermann, 1911 and 1919). Lactase had been reported from some species. Proteases and glycogenase also occur (Uvarov, 1928). It is apparent from the standpoint of the enzymes found present by various workers that phytophagous larvæ are capable of digesting a meat diet. That both proteases and diastases occur in carnivorous insects and phytophagous insects alike is well known.

As seen by the examination of fæces most of the constituents of a meat diet were utilized. Furthermore, all the

dietary requirements for complete development are met by a meat diet. The above considerations coupled with the fact that phytophagous larvæ have been successfully raised to maturity on a meat diet refute the belief that a plant diet is necessary for the well-being of these larvæ.

III

The following additional reports of cannibalism and the carnivorous habit have been gleaned from the literature.[1] Most of them may be explained on the basis of the principles set forth above and in a previous paper.

Riley, Packard, and Thomas (1883) stated that *Laphygma frugiperda* A. & S. and *Cirphis unipuncta* Haw. resort to cannibalism to satisfy their hunger when migrating. Many individuals are killed in this manner. Aitken and Davidson (1890) reported *Ornithoptera minos* Cram. as eating its own pupæ when normal food was wanting. Witfield (1889) regarded *Papilio ajax* L. as showing more highly developed cannibalistic propensities than any other Papilionid larva of his acquaintance. Floersheim (1909) found, on the contrary, that this species exhibits such behavior only during a shortage of food and then not very readily, since of twenty individuals but two were lost by cannibalism although the food shortage was extreme. Sorhagen (1899) listed all the cases (about eighty) of cannibalism known to him at the time. Forbes (1905) also reported *L. frugiperda* as being cannibalistic in nature when migrating. *Thecla w-album* according to Tutt (1905-1906) is commonly supposed to leave its food in order to feast upon the newly-formed pupæ of its own species. Hering (1926) designated eighty-one species as "Mordraupen" of which nine cases had been reported as occurring in nature. This list is based on that of Sorhagen. Lommatzoch (1926) reported *Spilosoma lubricipeda* Esp. as eating a dead noctuid when its food supply had been exhausted. The report of Junglung (1930) that *Scopelosoma satellitia* L. resorted to coprophagy in captivity when food was lacking is interesting. Small larvæ

[1]Berg's paper quoted in Psyche 44(4): 114, 1937 was also reviewed in Kosmos, Zeit. f. einheitliche Weltanschauung auf Grund der Entwicklungslehre, 3: 362-363, 1878.

of *Carpocapsa pomonella* L. when crowded exhibit cannibalism (Balduf, 1931). Buckstone (1938) recorded an instance in which the larvæ of *Pieris rapae* L. and ova of *P. brassicae* were confined in the same box. When the latter emerged, they ate the former although the enclosed cabbage leaves were still fresh.

With further regard to cannibalism under natural conditions I am grateful to Dr. H. G. Crawford of the Department of Agriculture, Canada for permission to quote from correspondence with departmental officers in the field.

During the summer of 1938 outbreaks of *Cirphis unipuncta* Haw. occurred but no cannibalism was observed. However, Mr. R. P. Gorham reported that larvæ under laboratory conditions fed on pupæ although they showed no interest in larvæ even when massed together in great numbers. The same officer noticed no cannibalism in *Nephelodes emmedonia* Cram. *Agrotis fennica* Tausch repeatedly attack one another in captivity. Mr. Gorham is of the opinion that most of our common garden cutworms are cannibalistic on pupæ in the laboratory. No cannibalism was observed in *Euxoa ochrogaster* Guen. or *Loxostege sticticalis* L. Mr. K. M. King and Mr. H. L. Seamans report that larger larvæ of *Agrotis orthogonia* Morr. attack smaller and weaker ones especially in the laboratory. *Chizagrotis auxiliaris* Grote according to Mr. Seamans is markedly cannibalistic under conditions of migration. When the advance of the larvæ is checked by some obstacle such as a furrow, the weaker larvæ are quickly attacked. Curiously enough larvæ which have been killed by poisoned bait are frequently eaten.

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ADDITIONAL RECORDS OF ONYCHOPHORA FROM THE ISLAND OF HAITI

BY CHARLES T. BRUES
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When he visited Haiti several years ago Dr. P. J. Darlington, of the Museum of Comparative Zoology, obtained specimens of Onychophora from a number of localities in the Republic of Haiti. These proved to represent five distinguishable forms of the genus Peripatus *s. str.* Two of these, *P. manni* Brues and *P. dominicæ* Pollard, var. *haitiensis* Brues had been previously described by the writer from material collected by Dr. Wm. M. Mann.[1]

The other three are additional forms of *P. dominicæ* and were described as varieties by the writer from Dr. Darlington's material.[2]

Quite recently Dr. Austin H. Clark[3] described another species belonging to the related genus Macroperipatus from Haiti as *M. insularis.* This augments the list of Haitian Onychophora to six, including two genera and three species, one of the latter with four named varieties.

Last autumn Dr. Darlington again visited Haiti, this time extending his investigations eastward into the north and central portions of the Dominican Republic. There he secured series of Peripatus at five additional localities.

An examination of these series shows them all to be referable to *P. dominicæ* Pollard, var. *basilensis* Brues previously known from Mount Basil in the northwestern part of the island.

The distribution of *basilensis* is thus greatly extended by this material as indicated below.

(1) Mt. Diego de Ocampo, Northern Range, Dominican Republic. 3500-4000 feet (July 1938). One specimen, quite typical, but with 30 pairs of legs instead of 28 as in the type.

(2) North slope of Loma Rucilla, Central Range, Domin-

[1]Bull. Mus. Comp. Zool., vol. 54, pp. 519-521 (1913).
[2]Psyche, vol. 42, pp. 58-62 (1935).
[3]Proc. U. S. National Mus., vol. 85, No. 3027, p. 3 (1937).

ican Republic, about 8000 feet (June 1928). Six specimens with 27 pairs (four individuals) or 28 pairs of legs (two individuals).

(3) North of Loma Rucilla, Central Range, Dominican Republic, 6000-7000 feet (June 1938). Two large females, each with only 26 pairs of legs.

(4) Constanza, Central Range, Dominican Republic, 3000-4000 feet (August 1938). Eight specimens with 27-31 pairs of legs; one ♂ with 27 pairs, one with 29 pairs, four with 30 pairs and two with 31 pairs.

(5) Vic Valle Neuvo, southeast of Constanza, Central Range, about 7000 feet (August 1938). Two specimens, each with 28 pairs of legs.

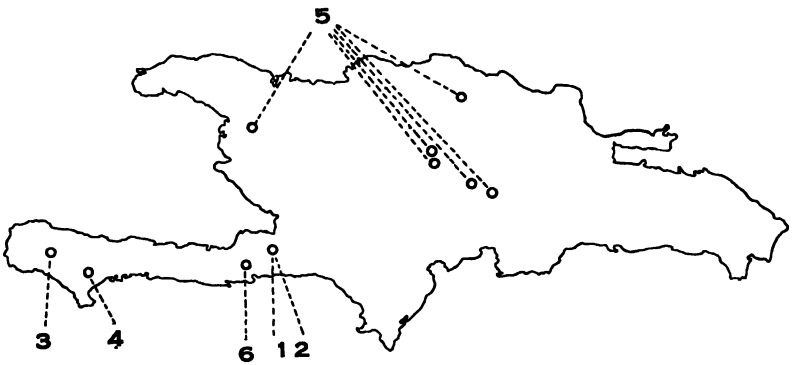

Fig. 1. Outline map of Haiti showing the known distribution of Onychophora. 1, *Peripatus manni;* 2, *Peripatus dominicæ,* var. *haitiensis;* 3, *Peripatus dominicæ,* var. *darlingtoni;* 4, *Peripatus dominicæ,* var. *lachauxensis;* 5, *Peripatus dominicæ,* var. *basilensis;* 6, *Macroperipatus insularis.*

It thus appears that *Peripatus dominicæ* var. *basilensis* extends eastward from Mt. Basil into the Northern Range of Mountains and also into the Central Range. All of the specimens listed above are very similar to the types although many of them have more pairs of legs. However, the number apparently never reaches that present in what I have considered to be the nearest relative, var. *darlingtoni* Brues which is so far known only from well out on the southwestern peninsula on the Massif de la Hotte.

The accompanying outline map, kindly drawn for me by Mrs. A. S. O'Connor summarizes our present knowledge of the distribution of Onychophora on the island of Haiti.

ON THE GENUS ABARIS DEJ. (COLEOPTERA; CARABIDÆ)

BY S. L. STRANEO
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I have been trying for many months to secure typical examples of all of the known species of the genus *Abaris* Dej., for a revision of the genus. However, I have been unable to secure all of them, so I shall limit myself here to some notes on the genus.

Chaudoir in his notes on *Abaris* (Bull. Soc. Nat. Moscou XLVII, 1873, p. 97) has written: *"Abaris picipes et striolatus qui ont . . . les segments abdominaux sillonnés"*; but he was wrong, because Bates in the original description of *Abaris picipes* said, *"ventre haud sulcato"* and, *"there is no appearance of a transversal groove on the ventral segments"*. He said also (Biologia Centrali-Americana, p. 85) that *Abaris picipes* Bates is really an *Abaris*, but he put the species with *Abaris striolata* Bates. In the Junk Catalogue, Csiki has omitted *Abaris striolata* Bates. This species, known to me only from description, has the claws of the tarsi pectinated (Bates, *l. c.*, p. 85) and the ventral segments grooved; owing to these characters, it should be inserted in the genus *Abaridius* Chaud. or in a new genus near *Abaris* and *Abaridius*.

Here follows the description of a new species found in the material sent to me by P. J. Darlington Jr. of the Museum of Comparative Zoölogy of Cambridge, Massachusetts.

Abaris darlingtoni n. sp. (fig. 1)

Aeneous, lightly virescent, head and pronotum very shiny, elytra a little less nitid; antennae, legs, and mouth ferrugineous, joints 1-3 of antennae a little darker in the middle, femora and apex of mandibles darker, lateral margin of pronotum ferrugineous, last ventral segment at apex broadly flavous. Length: 5.5 mm.; max. lat. 2.1 mm.

Head very similar to that of *Abaris aenea* Dej.; large, smooth, neck evidently constricted, eyes large and convex, frontal foveæ moderately deep, short, rather united by a vague frontal impression behind clypeal suture.

Prothorax wide, sides gently rounded, lateral margin slightly explanate and moderately reflexed in basal half, median line very fine, interior basal foveæ rather deep, the exterior ones more superficial, with a few large punctures, and rugosities, not extended to lateral margin; anterior margin a little less wide than the head with the eyes; base distinctly wider than the anterior margin.

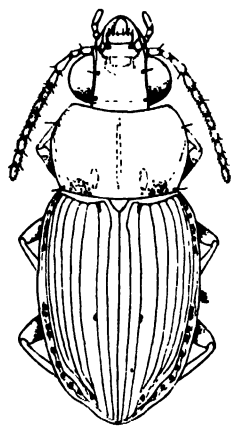

Fig. 1. *Abaris darlingtoni* n. sp.

Elytra oblongo-ovate, a little wider than the prothorax, one half longer than wide, with the greatest width before the middle; striæ strongly impressed, the scutellary one vestigial; third interstice a little less wide than the first and second together, with a single puncture behind the middle.

Underside smooth, metapisterna long, ventral segments not sulcate.

Claws of the tarsi finely pectinated; onychium with some fine setæ on the underside.

The microsculpture, invisible on the prothorax, on the elytra is rather faint and transversal.

Locality: Panama Canal Zone: Barro Colorado Island (Van Tyne and Darlington), 2 examples. Holotype in the

Museum of Comparative Zoölogy at Cambridge, Massachusetts (type no. 23,393); allotype in coll. Straneo.

This new species is closely allied to *Abaris aenea* Dej. and *notiophiloides* Bates by the lack of a scutellary stria and by the lateral margin of the pronotum distinctly reflexed near the basal angles. Compared with *A. aenea* Dej. the 3rd interstice of elytra is wider (nearly as wide as in *notiophiloides*) and the lateral margin is a little less reflexed near the base: compared with *A. notiophiloides* Bates, the legs are ferrugineous and the femora darker (in *notiophiloides*, flavo-testaceous) and the base of the pronotum is punctured only near the basal foveæ (in *notiophiloides*, also in the basal part of lateral margin).

KEY TO THE SPECIES OF THE GENUS ABARIS DEJ.

(1)	(8)	No scutellary stria.
(2)	(7)	Lateral margin of pronotum in the basal part wide and distinctly reflexed.
(3)	(4)	Third interstice of elytra subequal to or only a little wider than second. ..... *aenea* Dej.
(4)	(3)	Third interstice of elytra distinctly wider than 2nd, about as wide as first and second together.
(5)	(6)	Legs flavous; base of pronotum punctured, including the basal part of lateral margin. .... *notiophiloides* Bates
(6)	(5)	Legs ferrugineous red, femora darker; base of pronotum punctured only near basal foveae. .... *darlingtoni* n. sp.
(7)	(2)	Lateral margin of pronotum even near base narrow and not reflexed. .... *aequinoctialis* Chaud.
(8)	(1)	Scutellary stria present and rather elongate.
(9)	(10)	Size smaller (5-5.5 mm.). *basistriatus* Chaud.
(10)	(9)	Size larger (6.5-8 mm.).
(11)	(12)	External basal foveae of pronotum not distinct, because lateral margin is widely reflexed. .... *robustulus* Tschit.

(12) (11) External basal foveae of pronotum very distinct, lateral margin of the pronotum not reflexed (from description). .... *bigenera* Bates & *picipes* Bates

I do not know these last species, and in the original description there are no useful differential characters, for *A. bigenera* is compared with *Pseudobaris substriatus* Chaud. which belongs to another genus.

I have to thank Mr. H. E. Andrewes and Dr. P. J. Darlington Jr. for the specimens kindly sent to me for examination, and my friend Dr. F. Capra for his help in connection with old descriptions.

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NOTES ON BUTTERFLIES FROM HISPANIOLA

BY MARSTON BATES

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The island of Hispaniola, broken into many life zones and habitats by its lofty mountain ranges, presents the most interesting—and least known—fauna of any island in the West Indies. Sharpe (1898) and Hall (1925) have given lists of butterflies from the island, the latter enumerating 139 species. The Hispaniolan butterfly fauna is surely as large as that of Cuba and perhaps larger (159 species are now known from Cuba: Bates, 1935; 1936) and almost any collection from the island includes species not previously known from there. The Museum of Comparative Zoology and the American Museum of Natural History now have fairly extensive collections from Hispaniola, and a worthwhile study of the butterfly fauna could be made on the basis of this material. Since, however, there is little likelihood that any such study will be made in the near future, it seems best to publish the following notes on certain particularly interesting species.

The best account of the zoogeography of the island seems to be that of Wetmore and Swales (1931) and most of the localities mentioned in the present paper can be found on their map.

The nomenclature and sequence used in the present paper conforms with that of my "Butterflies of Cuba" (Bates, 1935).

Eurema dina (Poey)

There seem to be two species of *Eurema* in Hispaniola belonging to the *dina* complex: one related to the Cuban

dina and the other to the Bahaman *helios*. Klots, in his revision of the genus Eurema (1929, p. 139) has considered that *dina* presents a peculiarly complicated taxonomic problem; but this may be due to the frequency with which morphologically distinct local populations are encountered. Individuals from a given population seem to have a quite uniform facies, as is shown by the long series in the M. C. Z. from Cuba *(dina)*, New Providence *(helios)* and Honduras *(westwoodi)*. There is considerable variation in the genital structures as Klots (1928, p. 66) has pointed out; but this variation seems in part at least to be geographical.

The Bahaman populations that I have called "*Eurema chamberlaini* Butler" (Bates, 1934, p. 134) seem to belong to the *dina* complex, and the Cuban *Eurema laræ* (Bates, 1936, p. 226) may also belong there, although as our only specimen lacks the abdomen it is impossible to place it with any certainty. The Puerto Rican *Eurema sanjuanensis* (Watson, 1938) is unknown to me.

The known West Indian *dina* populations might, then, be arranged as follows:

Eurema dina dina (Poey) Cuba
dina memulus (Butler) Hispaniola
dina parvumbra (Kaye) Jamaica
laræ (Herrich-Schäffer) Cuba
helios helios Bates New Providence, Andros
helios mayobanex subsp. nov. Hispaniola
chamberlaini chamberlaini (Butler) Great Inagua
chamberlaini mariguanæ Bates Mariguana
chamberlaini subsp. indescr. Cat Is.

Eurema dina memulus (Butler)

Terias memulus Butler, 1871, p. 251, pl. 19, f. 6.

♂. Wings above light orange, somewhat deeper in color toward the margins; apex of forewing black, the inner edge of this black patch evenly rounded or slightly dentate, extending from a point about two thirds of the way out on the costa to the inner angle. Under side yellow: immaculate or with scattered brownish spots on the hindwing. Length of forewing, 16–17 mm.

2 ♂ ♂ in the M. C. Z. from Haiti: Ennery (2500 ft., Aug., Bates) and "San Domingo" (Weeks Coll.).

This differs from the Cuban form *(E. dina dina)* in the complete absence of a black border on the hindwing, and in the greater extent of the apical black patch of the forewing. Our specimens agree very well with Butler's description and figure.

Eurema helios mayobanex subsp. nov.

♂. Wings above uniform orange, with a fine black border on the hindwing and a conspicuous border on the forewing, about the same as in the Cuban *dina*. Under side immaculate orange except for a minute double cell spot on the hindwing.

♀. Deeper orange toward the edge of the wings; no black margin to hindwing; apical border of forewing brown rather than black. Under side with a reddish patch at apex of forewing, and another on the margin of hindwing between veins Rs and M_1; some scattered purplish spots on disc of hindwing. Length of forewing, 20–22 mm.

Type (♂) and paratypes (2 ♂ ♂, 1 ♀) from Haiti: Ennery (2500 ft., Aug., Bates).

This form may be distinguished from *dina (s. s.), parvumbra* or *memulus* by the dark orange ground color of both sexes, and from *helios* by the comparatively broad apical border of the forewing.

The "distal process" of the male genitalia of *mayobanex* (Klots, 1928 for terminology) is about twice as wide as in *memulus*, and the various lobes are much more strongly developed in the former species. The genitalia of two specimens of *mayobanex* and of one of *memulus* were examined.

The four specimens of *mayobanex* and the Ennery specimen of *memulus* were all caught on the same day, as were specimens of *Eurema lisa* and *E. proterpia*.

Kricogonia castalia (Fabricius)

In the M. C. Z. there are 21 ♂ ♂, 7 ♀ ♀ from: Haiti: Cabaret (Aug.); Mont Rouis (Aug.); Mt. Bourette, La Selle Range (5000 ft., Sept.); Cap Haitien; Rep. Dom.: Bonao (Aug.); Saona Is. (Jan.).

The pattern variation of this species seems to show no

geographical correlation, except insofar as certain populations seem to be more uniform than others (*e.g.*, the Bahamas). Very dissimilar specimens from the same region show identical structure in the male genitalia, but there seems to be some, though slight, geographically correlated variation in these organs. The genitalia of the Cuban *K. cabrerai* have not been examined, but the form seems to be distinct. With this exception it seems to me that, pending adequate material from all regions for comparative study, the best course is to treat the entire complex under the oldest name (*Papilio castalia* Fabricius, 1793, Entom. Syst., 3, 1, p. 188, presumably from Jamaica), and to describe the variation shown by different populations in terms as general as possible.

In the Hispaniolan series there are two types of males:

A, with the wings immaculate whitish above, except for the orange area at the base of the forewing, and a light longitudinal streak on the under side of the hindwing;

B, similar above except for a black postmedian bar on the costa of the hindwing, but with the underside of the hindwing uniform light yellow except for a shadow of the black bar of the upper side.

These two types show no intergrades; three specimens belong to type A, the remaining eighteen to type B. We have specimens like type A from Arizona, Nicaragua and Jamaica; like type B from Arizona. These might be considered as "incipient species" but the genitalia of A and B from Hispaniola seem to be identical and slightly different from the genitalia of A and B from Arizona!

Three types of females occur on Hispaniola:

C, above entirely lemon yellow, slightly darker at the base of the forewing; similar below, but with a prominent light longitudinal streak (really a fold) on the hindwing, and a faint silvery reticulation on this wing (1 specimen, Saona Is.);

D, chalky white above, darker on the base of the forewing; similar below, but bright yellow on the base of the forewing, the ground color of the hindwing and the apex of the forewing slightly yellowish, the fold of the hindwing prominent but not marked with contrasting scales (5 specimens);

E, similar but with an indication of a postmedian row of dark spots on the underside of the hindwing (1 specimen, Cabaret).

We have specimens of type C from Texas, Honduras and Nicaragua (the last somewhat intermediate between C and D); of type D from Texas; of type E from Texas. A sixth type with the apex of the forewing rather broadly marked with brown, and with the hindwing somewhat darker than the forewing above, occurs in Guatemala, Honduras and Arizona.

Dismorphia spio (Godart)

Pieris spio Godart, 1819, p. 167 (Antilles).

In the M. C. Z. there are 10 ♂ ♂, 9 ♀ ♀ from Haiti: Cap Haitien; La Hotte Peninsula, Camp Perrin, 1000 ft., Oct.; Etang Lachaux, Oct.; Rep. Dom.: San José de las Matas, 1000-2000 ft., June.

The variation in this series is very interesting. The two males from the La Hotte peninsula (Camp Perrin) may represent a distinct population, as they are smaller than any of the other specimens and have the yellow area of the costal margin of the upper side of the hindwing broadly connected with the orange postdiscal area, instead of separated by a black bar as in specimens from Cap Haitien. One yellow male from San José de las Matas, however, has the black bar only partially developed.

Both sexes of this species seem to be dimorphic: of the males in the series, six have orange markings and four have yellow markings; of the females, three are orange and six are yellow. Avinoff (1926, p. 363, pl. 33, f. 1) has described a yellow form from Puerto Rico as "ab. *virago*". The yellow females are strikingly similar to the normal females of the Cuban *Dismorphia cubana*.

Genus **Calisto** Hübner

In my review of the genus *Calisto* (Bates, 1935) I described five new species from Hispaniola, bringing the total known from the island up to nine. This seemed like a very large number of species, and I was greatly surprised to find two more very distinct new species in material collected by Dr. P. J. Darlington in the Dominican Republic in 1938.

One of these is the largest and most striking species of *Calisto* yet to be described. When the island is thoroughly explored, it will probably be found that the various mountain ranges are inhabited by distinct local populations of many of these *Calisto* species, and there is evidence of such geographical variation in some of the series in the collection of the M. C. Z.; there seems, however, to be no point in giving names to such subspecific populations at the present time.

Calisto arcas sp. nov.

♂ ♀. Sexes similar. Upper side: forewing: dark fuscous with a row of large more or less confluent submarginal fulvous spots extending from the inner margin to vein M_3; hindwing with the basal half fuscous, the distal half fulvous, except for a narrow, sharply defined, burnt orange submarginal line and a fuscous margin at the outer angle extending to vein M_3. Under side: forewing: dark reddish brown from base to just beyond cell, except for a black area along the inner margin; postmedian area fulvous, marked off by narrow brown lines; margin somewhat darker; ocellus in the fulvous area: black surrounded by a yellow ring; two bluish white central dots. Hindwing a rich brown, the basal half slightly yellowish, the distal half reddish; distinct antemedian, postmedian and submarginal dark lines; two ocelli of about equal size, both marked with yellow rings, the center black enclosing small, central, bluish-white dots; one ocellus in the M_1—M_2 area, the other in the Cu_1—Cu_2 area; an isolated white dot in the M_2—M_3 area; Length of forewing, 24—27mm.

♂. The androconia are limited to the Cu_1–Cu_2 and Cu_2–2A areas; they do not form a sharply defined patch. The genitalia of this species are quite distinctive: the uncus being asymmetrical, and the valves elongate, squared at the end.

Type (♂) and 3 ♂ ♂ 2 ♀ ♀ paratypes from Valle Nuevo, S. E. Constanza, Rep. Dom., Aug. 1938, c. 7000 ft., P. J. Darlington; 3 ♂ ♂ and 3 ♀ ♀ from Loma Vieja, S. Constanza, Aug. 1938, c. 6000 ft., P. J. Darlington.

The position of vein R_1 of the forewing, which arises at the end of the cell, and the symmetrical ocelli of the hind-

wing, indicate that this species should be put in the Archebates Group. It differs strikingly, however, from the other members of this group and from all other species of the genus both in genital structure and in pattern. It is the only known species with fulvous markings on the upper side of the forewing, and the only species, except the new one described below as *grannus*, with two symmetrical ocelli on the under side of the hindwing.

Calisto chrysaoros Bates

Dr. Darlington captured four specimens of this species in the "foothills of the Cordillera Central S. of Santiago" and one "between Constanza and Valle Nuevo, 6000 ft." in the Dominican Republic. These differ from the typical specimens from the La Hotte and La Selle mountains of Haiti in having the under side of the hindwing fuscous rather than brown, and in having the white median band of this wing somewhat nearer the similar band over the ocellus. This species, then, seems to occur at high elevations in several parts of the island.

Calisto grannus sp. nov.

Upper side: dark fuscous, the disc of the forewing (androconia patch) very dark. Under side: forewing: fuscous, with a fine dark postmedian line extending from the costal to the inner margin, and with two wavy submarginal lines along the outer margin; ocellus of the usual design: black, ringed with yellow, with two minute white pupils. Hindwing: fuscous, with fine reddish-brown antemedian and postmedian lines and with two very irregular submarginal lines; two symmetrical ocelli (black ringed with yellow or orange, with a single central white dot): one, slightly smaller, in the M_1–M_2 area, the other in the Cu_1–Cu_2 area; a prominent white spot in the M_2–M_3 area and another in the M_3–Cu_1 area. Length of forewing, 16–18 mm.

♂. Androconia patch like that of *C. hysius*. Genitalia strikingly similar to those of *C. hysius*, differing only in details of proportion and chitinization.

Type (♂) and one paratype ♂ from Valle Nuevo, S. E. Constanza, Rep. Dom., Aug. 1938, c. 7000 ft., P. J. Darling-

ton; 3 paratypes ♂ ♂ from Loma Rucilla, June 1938, 8000 ft., P. J. Darlington.

The three specimens from Loma Rucilla differ from the others in that the lines of the under side are more obscure, the ocellus of the forewing smaller.

This species, structurally, seems to be close to *C. hysius*, but it differs from all other species of the *hysius* group in having two symmetrical ocelli on the under side of the hindwing—instead of one asymmetrical ocellus—and in the absence of a distinct red patch in the cell of the forewing.

Calisto pulchella Lathy

Dr. Darlington caught four males of this species in the Constanza region (3000–4000 ft.) which differ rather strikingly from the common Haitian form in having the under side of the hindwing marked with orange rather than reddish-orange, and in having the antemedian and postmedian lines more widely separated.

Hypolimnas misippus (Linnaeus)

There is one male in the M. C. Z. collection from Haiti: Cul-de-Sac Plain, Jan., A. Audant. This is the first record of the species from Hispaniola.

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NOTES AND DESCRIPTIONS OF ORIENTAL ŒSTROPSYCHINÆ (TRICHOPTERA)

By Nathan Banks

Museum of Comparative Zoology

There are a number of species in this group in the Orient, although for many years it was the custom to call every specimen of Polymorphanisus, *P. nigricornis*, and every Œstropsyche as *Œ. vitrina*.

Having a considerable number of specimens from India, it is seen that each is fairly constant in structural characters, both of body and wings.

Polymorphanisus

The species of this genus fall into two sections; one with the fourth fork sharply acute at base and extending well back on the median cell and with the fore wing not especially broad; to this belongs *nigricornis* and some allied forms; the other section has broad, rather short wings, and the fork four is broad at base and goes back but little, if at all, on the median cell; to this group belong *indicus*, *ocularis*, *astictus*. The females of the first group from Asia known to me can be separated as follows:

1. Head swollen in front in a rounded lobe, mesoscutellum with two black stripes, discal cell very short *tumidus*
   Head not prominently swollen in front 2
2. Fringe of mid tarsi blackish, antennæ black 3
   Fringe of mid tarsi paler 4
3. A dark spot on mesoscutellum, discal cell short, front legs pale ..... *unipunctus*
   No spot on mesoscutellum, discal cell about one half as long as median cell, front tibiæ and often femora blackish ..... *nigricornis*

4. Legs yellowish, fringe of mid tarsi yellowish; antennæ dark only at joints; front tibiæ with only a dark dot at tips ..... *flavipes*

   Legs pale, not distinctly yellowish, fringe of mid legs silvery, outer half of front tibiæ black; fore wings rather broader than usual ..... *hainanensis*

P. taonicus Navas from South China I do not know.

Polymorphanisus nigricornis Walk.

Walker says the antennæ and the fringe on legs black. This form has the front tibiæ more or less dark, and often the femora also. The discal cell is about one-half as long as the median cell, fork one longer than its pedicel, fork four well back on median cell, but not halfway to the cross-vein, latter before middle of cell, cross-vein from median fork to cubitus is straight and about twice its length before base of median cell. There are no distinct marks on the mesonotum, nor does Walker mention any.

Many specimens from Shimoga, Mysore, India.

Polymorphanisus unipunctus Bks. Fig. 4

From Suifu (Graham) and Chin Chi Shan (Gaines Liu), both Szechuan; fork one is very short as well as the discal cell.

Polymorphanisus flavipes sp. nov.

Pale greenish, rarely a trace of dark each side on the mesonotum, abdomen dark, ventral segments more or less tipped with pale; antennæ pale, sometimes somewhat darkened toward tips, the joints narrowly black at tips, basal joint behind with a black streak; legs yellowish, front and mid tibiæ with dark dot at tips, fringe of mid legs plainly yellowish.

Wings greenish, with green veins; discal cell rather short, not one-half of median cell; fork one longer than pedicel, fork four back on median cell about width of median, not halfway to the cross-vein which is much before the middle of cell; cross-vein from median fork to cubitus

about two and one-half times its length before median cell; venation of hind wings much as in *nigricornis*.

Length of fore wing 20 to 23 mm.

From Shimoga, and Bhadravati, Mysore, India, in May, June, August, September, and October (Susai Nathan). Two specimens with rather more yellowish wings have a very distinct black spot each side on the mesonotum, and the fourth apical cell is more narrow than in the other specimens. Type M. C. Z. no. 23467.

Polymorphanisus tumidus sp. nov. Figs. 11, 12

Pale greenish, abdomen dull black, mesoscutellum with two short black stripes, antennæ greenish, black mark at the joinings, legs pale greenish, front pair unmarked, mid legs with the tibiæ and tarsi yellowish, a black spot at tips of tibiæ and tarsal joints, the fringe brownish yellow; front of head with a great, smooth, rounded swelling in front.

Fore wings greenish, veins green; discal cell very small, only about one-fourth as long as median cell, and fully as high as long; fork one about three times as long as the pedicel, fork four well back on median cell, but not halfway to the cross-vein, which is much before the middle of cell; cross-vein from median fork to cubitus fully three times its length before median cell; venation of hind wing much as usual.

Length of fore wing 19 to 20 mm.

From Shimoga, Mysore, India, 15 to 28 April (Susai Nathan coll.). Remarkable for the peculiar head. Type M. C. Z. no. 23468.

From the larger Malayan islands there are at least three species, and doubtless more.

Polymorphanisus semperi Brauer

In some specimens there are two faint dark marks on the mesoscutellum, and also present more plainly in all three males I have seen. All of my specimens are from Luzon.

Polymorphanisus fuscus Ulmer

Two females from Telang, Borneo (Grabowsky) have the black spots near base of fore wings; the mesoscutellum is

almost wholly black, and two narrowly separated black spots in front on the margin of the mesonotum.

Polymorphanisus scutellatus sp. nov. Fig. 9

Pale yellowish to greenish; no marks on head nor legs; antennæ pale, narrowly dark at tips of joints; mesoscutellum with two black spots; abdomen dull black. Wings greenish, veins green, the veins about discal cell and several apical veins in upper part are bordered with yellowish, much as in *P. semperi.*

Fore wings moderately slender, about as *nigricornis,* not at all sinuate on outer margin; discal cell is four-sided, fork two rather deeply indenting the anastomosis, the discal cell not nearly one-half as long as the median cell, cross-vein from lower side of discal to the median is obliquely backward; median cell very long, not nearly as wide as discal, fork four extending back on the median cell about one-half the width of cell; cross-vein from median cell to cubitus before middle of cell; fork one not nearly as long as its pedicel.

Venation of hind wing much as in *semperi,* except that fork five is only one half as long, shorter than in any other species noted.

Length of fore wing 15 to 18 mm.

From Baram River district, Sarawak, Borneo (H. W. Smith 1912); others marked Sarawak, and one from Hagen collection, Duson Tinoc, Borneo (Grabowsky). Type M.C.Z. no. 23472.

Differs from *semperi* by shape of fore wing and many points of venation.

A specimen from Buitenzorg, Java (T. Barbour) and one from Medan, Sumatra (G. Fairchild) have the same venation but the mesoscutellum is almost wholly black, and quite possibly represent another species.

Œstropsyche vitrina Hagen Figs. 5, 14

Both of Hagen's males have the median cell longer than figured by Ulmer (Selys Monog. Trich. (2) fig. 21) for his Celebes or Sumatra specimen. Fork four is also more geniculate at base than he figures; in the hind wing the

venation is much as he figures but forks two and three are well separated at base.

Œ. palingenia Brauer from the Philippines is distinct, and probably also some other island forms. In the female of *palingenia,* the discal cell is not so wide as in the male, and is nearly as far from the radius as its own width, and fork two is not short-pedicellate, but only much narrowed at base. I figure (Fig. 2,) the appendages of a male from Mt. Makeling, Luzon (U.S.N.M. coll.).

I have from India another species, possibly the one referred to *vitrina* by Martynov (Rec. Ind. Mus. XXXVII, p. 93). I give a figure of the fore wing of the type of *Œ. vitrina.*

Œstropsyche hageni sp. nov. Fig. 6

This has the same general appearance as Hagen's species, but is smaller; fore wing 12 mm., Hagen's type 15 mm. The median cell is about a fourth shorter than *vitrina,* with a very short margin on the cubitus, the inner side less sinuate, the fork four fully as much curved at base. In the hind wing fork one is very short, otherwise like *vitrina.* In the mid legs the second tarsal joint is nearly one-half of the first, in *vitrina* scarcely more than one-third, and the membranous margin is of a more even width.

The genitalia have the claspers of about the same proportions as in *vitrina,* but the tip of the penis in *vitrina* has a projection below, which is lacking in *hageni;* from above the superior plate is slightly projecting in the middle.

From Shimoga, Mysore, India, 21 July (Susai Nathan). Type M.C.Z. no. 23469.

Amphipsyche apicalis sp. nov. Figs. 1, 3, 8, 15

♂ Pale yellowish, face silvery on the sides, thorax and apical part of the abdomen rather darker yellow; legs pale whitish, unmarked; antennæ pale, joints narrowly dark at tips; palpi long, apical part rather dark.

Fore wing sparsely clothed with yellowish hair, more yellowish along anal margin, a brighter yellowish cloud before anastomosis, another one transversely beyond anastomosis, and the apical part broadly yellow, in the apical

part of fork one is a rounded black spot; hind wings pale whitish. Fore wings rather long, tip broadly rounded. Venation much as in *A. nirvana* (*indica*), the radius strongly sinuate, radial sector nearly straight, median cell more slender than usual, a minute cell at base of fork two which is pedicellate; hind wings much as in other species, the cubital fork slender, as in *A. tricalcarata.* Spurs 1, 4, 4, the subapical pair of hind legs rather small and close together, but plainly two. Male genitalia above much as in *A. distincta,* but from beneath the claspers have the basal part very slender, not at all enlarged as in *distincta;* the penis has a large hump beyond middle, further from the tip than in *A. nirvana,* and the tip of penis, seen from below (or above) is slender and bifid.

Fore wings 13 mm. long.

From Shimoga, Mysore, India, 10 April (Susai Nathan). Type M.C.Z. no. 22677.

Two females from Coimbatore, have fork two pedicellate, but no cell at base, a small dark cloud near upper end of anastomosis, hind tibia with but one preapical spur, may be the female of this species.

Amphipsyche distincta Mart.

A species agreeing in genitalia, head and thorax markings and in venation is common in Mysore, India. Martynov does not mention the front femora which in these specimens are plainly blackish, and show very prominently from in front. The wings of fresh specimens are very plainly greenish. The female also has these black front femora, is smaller, the wings scarcely at all green, but the abdomen is green (at least when fresh). The mesonotum usually has a dark stripe each side, and scutellum largely dark; the brown on head as in male. The mid tibia are broadened as usual, there is a distinct, but sometimes minute, subbasal spur, and the apical spurs are simple, but inner much shorter than outer; hind legs with only the apical spurs. The venation is similar to that of the male, except that the radius, of course, is but little curved near tip, and the cross-vein from median cell to lower median vein is usually much nearer to the middle of cell, radial sector straight. The fore wing is

but 6.5 mm. long, male 9 mm. Many from Shimoga, Mysore (Susai Nathan).

Amphipsyche magna sp. nov. Figs. 13, 16, 17

Head and thorax pale yellowish, with more pale hair than usual; abdomen brown; antennæ pale, tips of joints dark; mesonotum with a brown stripe on each side toward wing-base, and a spot each side on the posterior part of mesoscutellum; metanotum with a brown spot each side in front; legs pale yellowish, unmarked; fore wings pale yellowish with yellowish veins (green alive?), the subcosta and radius faintly bordered with yellowish; hind wings very pale.

In fore wings the venation is typical; about seven faint costal cross-veins; the subcosta before tip bends down and then up, and the radius close by follows it, beyond which the radius makes a deep bend; fork one about equal to its pedicel; the median cell broad and rather short, upper side in an even curve.

Legs slender, femora fringed, spurs 1, 4, 2, one of the subbasal pair of mid leg is curved. From above the genitalia show a broad, deeply divided superior plate, the long arms slightly divergent, and almost swollen before tip; the claspers are long and very slender, the apical part straight, tapering, and hardly one-half of the basal part; the tip of the penis from behind appears round, the two dark, pointed processes standing upright, some distance apart.

Fore wing 19 mm. long.

One from Del Carmen, Philippine Islands (Uichanco), 15 Nov. Type M.C.Z. no. 23471.

Amphipsyche delicata sp. nov. Figs. 7, 10

A small, pale yellowish gray species with unmarked wings. Head pale yellowish; antennæ pale, faintly, narrowly annulate with dark; palpi pale, fully as long as usual; legs pale, front tibia with a minute dark spot at tip; fore wings pale yellowish gray, unmarked, the stigmal area rather more yellowish than elsewhere. Venation much as usual, but the median cell extends much beyond the anastomosis, rather more so than in *A. minima*, the median cell is not so much widened in the middle as in *A. minima*,

and its upper border is plainly thickened; fork one is scarcely longer than pedicel; one costal cross-vein fairly distinct and sometimes a second shows, fork two sessile.

Mid leg of female with tibia less swollen than in most of the larger species; spurs 0, 4, 4, the preapical pair of hind legs very small, and one of the apical pair is much longer than the other.

Length of fore wing 7 to 7.5 mm.

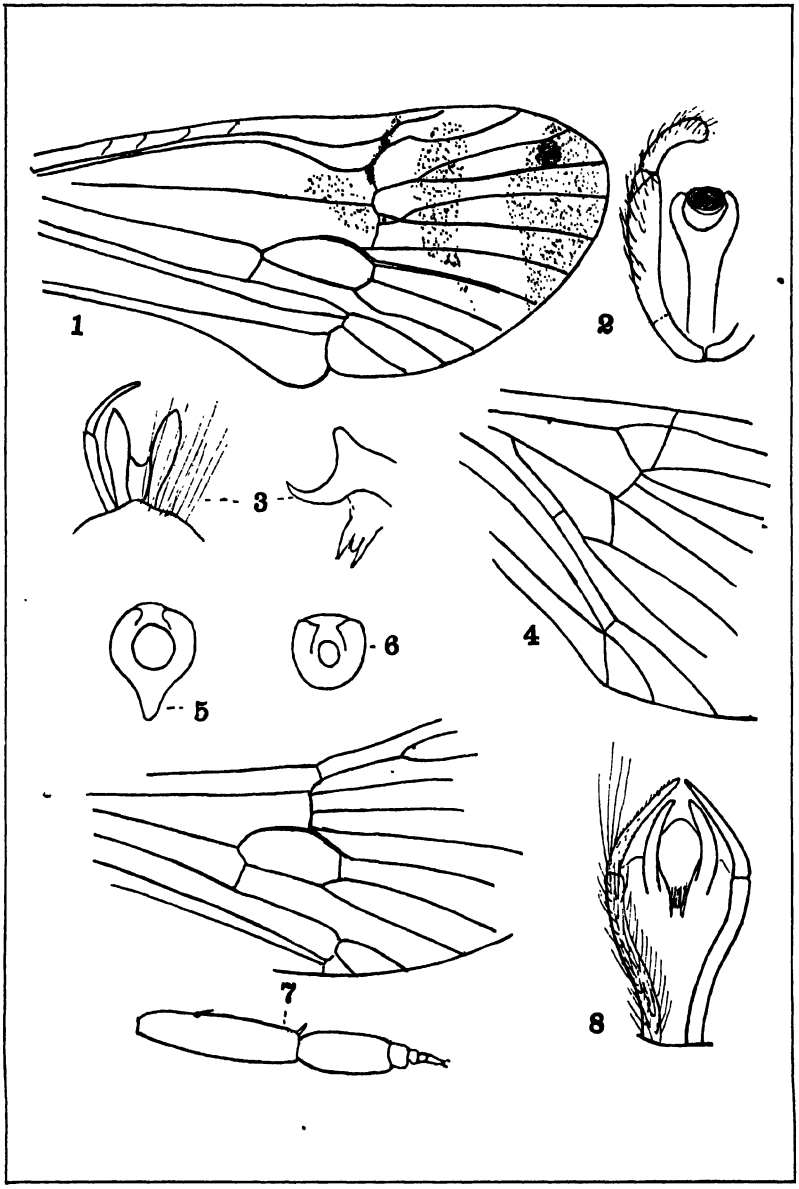
From Chung Kon, 18 July; Dome Mt. 13 July, both on Hainan Island, and Kit Tau, South Kiangsi, China, 20 June (Gressitt). Type M.C.Z. no. 23470.

It differs from *A. minima* in not having fork two pedicellate, in lacking the faint brown band over anastomosis, and in shape of the median cell; from the equally small *A. distincta* it differs in not having front femora and tibiæ darkened, in shape of the median cell, etc.

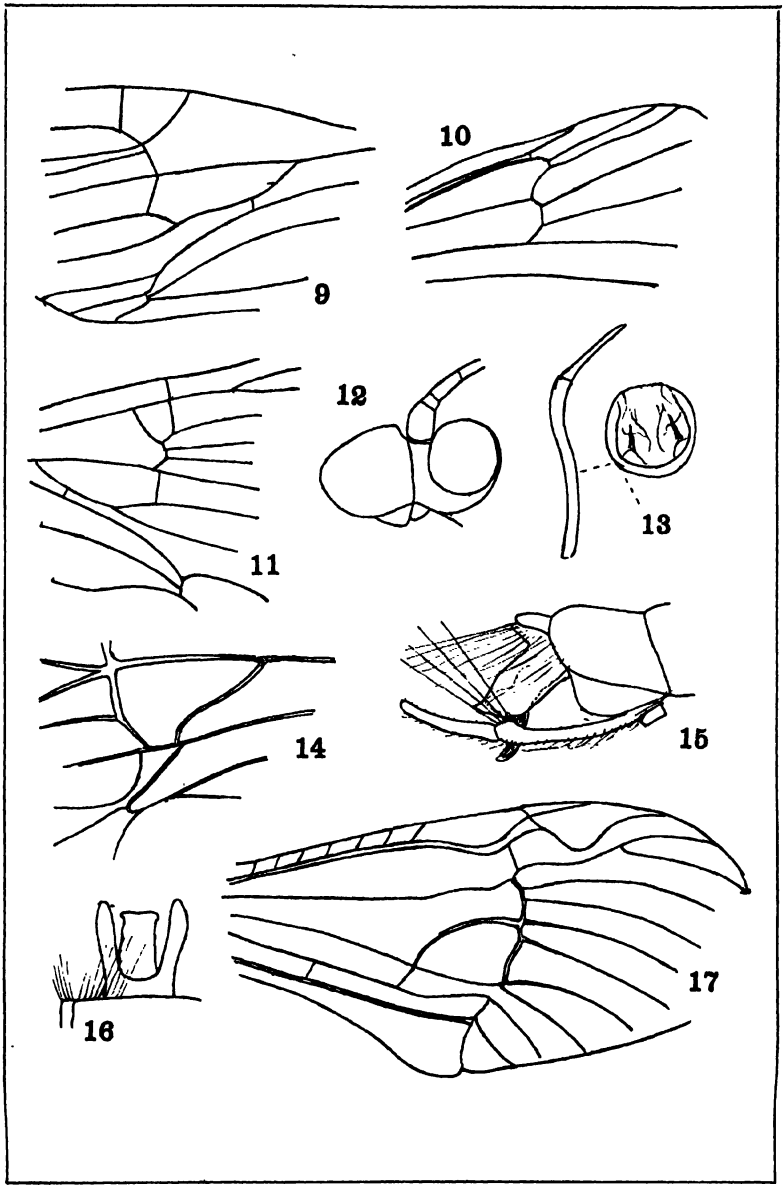
Explanation of Plates I and II.

Fig. 1. *Amphipsyche apicalis*, fore wing.
2. *Œstropsyche palingenia*, genitalia below.
3. *Amphipsyche apicalis*, genitalia above, and penis from side and above.
4. *Polymorphanisus unipunctus*, part of fore wing.
5. *Œstropsyche vitrina*, tip of penis.
6. *Œstropsyche hageni*, tip of penis.
7. *Amphipsyche delicata*, part of fore wing and hind leg.
8. *Amphipsyche apicalis*, genitalia below.
9. *Polymorphanisus scutellatus*, part of fore wing.
10. *Amphipsyche delicata*, part of hind wing.
11. *Polymorphanisus tumidus*, part of fore wing.
12. *Polymorphanisus tumidus*, head from side.
13. *Amphipsyche magna*, tip of penis and clasper.
14. *Œstropsyche vitrina*, median cell of fore wing of male.
15. *Amphipsyche apicalis*, genitalia, side.
16. *Amphipsyche magna*, superior plate, above.
17. *Amphipsyche magna*, fore wing of male.

PSYCHE VOL. XLVI PLATE 1



Banks — Oriental Œstropsychinæ



Banks — Oriental Œstropsychinæ

A PTILIID BEETLE FROM BALTIC AMBER IN THE MUSEUM OF COMPARATIVE ZOOLOGY

BY C. T. PARSONS

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In so far as no fossil *Ptiliidae* have as yet been given names, it may be of interest to describe a species of *Ptinella* from the Oligocene amber of East Prussia.

Helm, 1896, merely mentions the occurence of the family in Baltic amber, and Klebs, 1911, states on the authority of Edmund Reitter that there is in his collection a *Ptenidium* and a new genus.

Today the genus *Ptinella* has a remarkable range. The twenty known species are distributed as follows: Europe (7, 2 of which also occur in the Canary Islands), Japan (1), Honolulu (1), New Zealand (1), North America (2), Central America (3), South America (2), St. Helena Island (1), and the Seychelles Islands (2). Since such a distribution indicates an ancient history, it is not surprising to find the genus in the Oligocene. Moreover, the living forms most commonly occur under the bark of *Betula, Quercus,* and particularly *Pinus,* all of which were common in northern Europe in the Oligocene.

Ptinella oligocœnica n. sp.

Fig. 1, a-e

The characters of generic importance are brought together in one paragraph. Body elongate; antennæ 11-jointed, long and slender, with long setæ, club elongate; head prominent, rather large; eyes moderate; thorax rather small, transverse, and constricted near the base; scutellum large, triangular; elytra abbreviated, with apices separately rounded; venter of six segments, with apical segment simple; legs rather long and robust, posterior coxæ remote

and apparently laminate, tarsi 3-jointed, with the apical joint very long and slender, claws long.

The body apparently corneous, somewhat depressed; head and antennæ as figured; outline of pronotum as figured, disc flat, surface sparsely punctate and transversely alutaceous, scutellum coarsely, closely punctate; elytra with discs flattened, humeral angles dentate, coarsely and closely punctate; metasternum sparsely punctate; first ventral segment punctate and as long as the following two combined; ventral segments 2-6 apparently smooth, apical segment with a fringe of hairs; femora and tibiæ covered with setæ; length .8 mm.

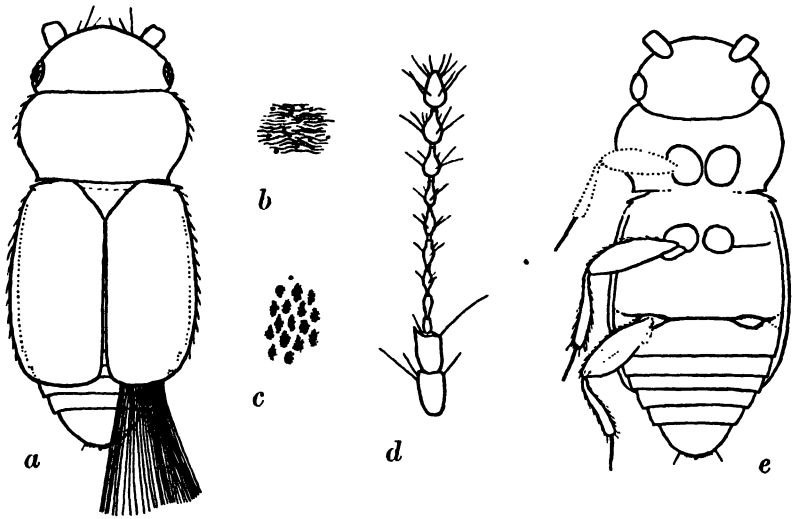

Fig. 1. Holotype of *Ptinella oligocœnica* n. sp. *a*, dorsal aspect; *b*, surface of pronotum enlarged; *c*, surface of elytron enlarged; *d*, antenna; *e*, ventral aspect.

The above description is from the holotype no. 6839 in the Museum of Comparative Zoology. There is also in the same museum a less satisfactory specimen which is designated paratype no. 6629. Both specimens are part of the W. A. Haren collection.

Because of cloudiness, many important characters of the underside cannot be seen. The one anomalous character

that can be made out is that the first ventral segment is unusually long. It is interesting that the muscles of the femur, as shown in the drawing of the hind leg, can be clearly seen.

This species differs from the types of *P. quercus* (Lec) and *P. fungi* (Lec.) in being more depressed, corneous, elytra longer, pronotum more transverse. The antennæ are identical with those of *P. quercus*.

PROTEPIPTERA, A NEW GENUS OF ACHILIDÆ FROM BALTIC AMBER (HEMIPTERA, FULGOROIDEA)

By Robert L. Usinger
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Through the kindness of Mr. Walter W. Kawecki, a former resident of the free city of Danzig but now in San Francisco, I have been able to examine a collection of insects preserved in Baltic Amber. The material was collected along the shores of the Baltic Sea between Danzig and Königsberg and the pieces of amber were polished by an amber worker in Danzig.

The collection contains a single specimen of a moderate-sized Fulgorid immediately suggestive of our familiar forest-dwelling genus *Epiptera* Metcalf (1922) (= *Elidiptera* Auct. part., nec Spinola, = *Helicoptera* Am. & Serv.). The specimen is beautifully preserved with the wings of the left side conveniently spread. Every detail of the under surface can be seen as readily as on a living specimen. The upper surface, however, is completely covered by a white cloud, as in many amber specimens. The apex of the front wing has been sharply broken off as if cut with a knife.

Evidently the family Achilidae has not previously been recorded from Baltic Amber. Scudder (1890) has doubtfully referred a single specimen (*Elidiptera regularis* Scudder) to this group from his Florissant material of Miocene age. However, the nine species of *Cixius* described from Baltic Amber by Germar and Berendt (1856) need to be reëxamined with a view to their possible inclusion in the Achilidæ. This family, or subfamily as it was then called, was not proposed until ten years later when Stål (1866) monographed the group in his usual masterly way. Stål's classification has been confirmed and expanded by Muir's detailed genitalic studies which indicate that the extension of the claval vein to the apex of the clavus is a really signifi-

cant character in separating the Achilids from their nearest allies (Muir, 1930). The specimen before me may be placed with certainty in the Achilidæ as distinguished from the Cixiidæ in which the claval vein enters the commissure before the apex. Unfortunately details of claval venation are not sufficiently clear in the figures of Germar and Berendt although it would appear that *C. vitreus* is a Cixiid while *testudinarius* is an Achilid. In size the present specimen is closest to *C. sieboldii* but, as the under side is invisible in that species, while the upper surface of the specimen before me is obscured, a direct comparison is impossible. Under the circumstances it seems best to propose a new specific name in order to avoid any possible confusion as to the identity of the genotype.

Protepiptera n. gen.

Similar to *Epiptera* Metcalf but with the vertex located distinctly in front of the eyes, its margins carinate and a longitudinal carina at middle; posterior margin of vertex concavely arcuate, subangulately so at middle, strongly, acutely produced postero-laterally and thus reaching or slightly surpassing level of anterior margins of eyes. Frons with its sides evenly arcuate, not abruptly narrowed between the eyes. Pronotum roundly projecting anteriorly between the compound eyes, the raised, carinate portion scarcely more than twice as broad as long.

Genotype: *Protepiptera kaweckii*, n. sp.

Protepiptera kaweckii n. sp.

A large, unicolorous species with very broad head, long pronotum, unicolorous frons, and very long rostrum.

Head three-fourths as wide, eyes included, as pronotum; vertex just twice as broad behind as long on median line; frons and clypeus together subelliptical, broadest a little before middle and attenuated posteriorly, about two and one-half times as long as greatest width, with a distinct longitudinal carina at middle. Rostrum reaching almost to tip of abdomen or, more precisely, to middle of subgenital plate. Antennæ rather prominent, over half as long as greatest width of frons; second segment over twice as long as first, the flagellum quite short, scarcely longer than main

portion of antennæ. Ocelli conspicuous as in *Epiptera*. Posterior margin of pronotum moderately, subangulately emarginate, the anterior and posterior margins laterally subparallel. Mesonotum one-fifth longer than width of head including eyes; disk obscured but with suggestions of three longitudinal carinæ. Legs more or less as in typical *Epiptera*, the front tibiæ one-sixth longer than femora. Posterior tibiæ two and one-half times as long as femora, each with a strong lateral tooth just beyond middle. Apices of hind tibiæ and first two tarsal segments beneath, each with a row of stout spines which are longest at the sides. First tarsal segment distinctly longer than second and third together. Venation on basal two-thirds of front wings precisely as in *Epiptera*, the wing broken off obliquely from beyond the apex of clavus to last of accessory subcostal branches.

Color rather uniformly dark brown, at least on the under side, with the under sides of the wings lighter and the ventral surface of the abdomen almost black.

Length 9.5 mm., greatest width approximately 3.5 mm.

This species will not fit in any of Kirkaldy's Australian genera (1906). It might fit the old definition of *Elidiptera* but certainly does not belong with the genotype, *callosa* Spinola, of that genus (see Muir, 1922). As noted elsewhere, it approaches Metcalf's recent genus *Epiptera* (1922) but differs in its anteriorly located vertex with a median longitudinal carina, non-constricted basal portion of frons between the eyes, very long pronotum, and somewhat longer tibiae.

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TWO NEW TINGITIDS (HEMIPTERA) FROM PANAMA

By Carl J. Drake

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The present paper contains the description of two new species of lace-bugs collected in the Canal Zone, Panama, by the author. The types are in the Drake Collection.

Gargaphia paula sp. nov.

Moderately short, broad, testaceous, the elytra with an oblique fuscous band near the apex. Head black, with five, pale, testaceous spines, the median and hind pair longer. Antennæ slender, moderately long; segments I and II black, the former stouter and three times as long as the latter; III long, testaceous, two and one-half times as long as IV; IV long, the distal three-fourths black. Pronotum black, the triangular portion testaceous. Carinæ foliaceous, testaceous, uniseriate; lateral carinæ not quite extending as far forward as the base of the hood, slightly converging behind; median carina slightly more elevated. Hood moderately large, roof-shaped above, highest in front, projecting slightly forward in front. Paranota moderately broad, testaceous, biseriate, the outer margin rounded.

Rostrum extending to the interrupted channel. Elytra very similar in appearance and markings to *L. lineata* (Champ.); costal are mostly biseriate, triseriate in widest part, the areolæ hyaline; subcostal area broad, triseriate in widest part. Body beneath black.

Length, 2.40 mm.; width, 1.10 mm.

Holotype, male, Barro Colorado Island, Canal Zone, Panama, Feb. 8, 1939, C. J. Drake.

The oblique fascia of the elytra and the small size separate this species from other members of the genus. The interrupted rostral channel separates it from *Leptopharsa lineata* Champion.

Leptopharsa zeteki sp. nov.

Small, narrow. Head black, the frontal spines short and black. Antennæ moderately long, slender; segments I and II both short, black, the former about twice as long as the latter; III a little more than twice as long as IV, testaceous; IV slightly enlarged, embrowned towards the tip. Rostrum brown, black at apex, extending beyond middle of mesosternum. Rostral channel wide, wider and chordate on metasternum. Legs slender, testaceous, the tarsi brownish. Body beneath black.

Pronotum convex, finely pitted, black, testaceous behind; carinæ foliaceous, uniseriate, testaceous, some of the veinlets dark, the areolæ small; lateral carinæ slightly concave within in front, not so widely separated and subparallel behind. Paranota rather narrow, biseriate, testaceous, slightly wider in front, moderately reflexed. Hood small, testaceous, faintly produced forward in front. Elytra moderately constricted beyond the middle, strongly overlapping and jointly rounded behind; costal area moderately wide, testaceous, biseriate, the inner row of areolæ along the basal half of costal area smaller, the areolæ hyaline; subcostal area broad, triseriate, the veinlets opposite discoidal area black; sutural area elongate, impressed, the nervelets somewhat embrowned, three areolæ deep in widest part; sutural area becoming dark fuscous posteriorly, with three large, hyaline areolae near the apex.

Length, 2.00 mm.; width, .80 mm.

Holotype (male), allotype (female) and one paratype, Barro Colorado Island, Canal Zone, Panama, Feb. 1939. Three paratypes, near Colon, Canal Zone.

The short basal segment of antennæ and color separate this insect from other small species of the genus. This species (also *G. paula* n. sp.) was collected near the Barro Colorado Island Biological Laboratory, Gatun Lake, Institute for Research in Tropical America, Panama Canal, and is named in honor of the Director, Mr. James Zetek, who has taken a very active interest in the insect fauna of tropical America.

NOTES ON HIPPOBOSCIDÆ
13. A SECOND REVISION OF THE HIPPOBOSCINAE

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Since the publication of my synopsis of the Hippoboscinæ (1931, Psyche, XXXVII, (1930), pp. 303-326), much additional information has come to light. One new species was described recently by the late G. A. H. Bedford and I was able to study several types, including those of *H. fulva* Austen.

In the alphabetical list of names (p. 306), *martinaglia* Bedford should be inserted as the ninth valid species; *longipennis* Fabricius is the valid name of *capensis* v. Olfers, which becomes a synonym; and *variegata* Megerlé (not to be credited to Wiedemann) is the valid name of *maculata* Leach, which passes in the synonymy.

As pointed out before, the Hippoboscinæ differ from other members of the family in several important characters. To those listed before may be added the presence of a pair of deep, more or less pit-like depressions, placed laterally on the suture between mesonotum and scutellum; also the well-defined pale yellow or white spots of head and thorax, which are not duplicated elsewhere in the family. While in other Hippoboscidæ color differences are of little or no specific value, in *Hippobosca* the shape and arrangement of the pale spots produces a pattern to a large degree diagnostic for each species. In this respect, there is an obvious analogy to the characteristic pattern of pale spots found in many species of ticks (*Amblyomma* and *Dermacentor*).

I have been at pains to discover additional specific characters, particularly in the case of closely allied forms. The chetotaxy has been neglected thus far, yet offers reliable differences which should be investigated by the accepted bio-

metrical methods. My material is not extensive enough for the purpose. Considering only the chetotaxy of the scutellum, this sclerite in *Hippobosca* bears at the extreme apical margin and somewhat ventrally a dense fringe of short, soft hairs. Anterior to the fringe one finds groups or rows of long, stiff bristles, either black or pale-colored, which I shall call the *preapical bristles.* The groups may be either far apart and restricted to the extreme sides or more or less connected medially. In some species the bristles are placed in one row, in others they form two irregular rows or are merely bunched together. When there are many bristles, these are often mixed with a few soft, short hairs, sometimes forming a second row behind the stiff bristles. In most cases the number and arrangement of the preapical bristles is the same in both sexes. There are two exceptions. In *H. struthionis* the males have more bristles on the average than the females. In the males of *H. camelina* the preapical bristles occupy the same position as in the other species of the genus; but in the females, the bristles are placed nearer the middle, being rather discal or medio-scutellar, and are also fewer in number than in the males. Except for this case of the female *H. camelina,* there are no discal nor basal bristles, setæ or hairs on the scutellum in *Hippobosca.*

The variation of the preapical bristles of the scutellum is discussed under each species, but the following summary compares the species for diagnostic purposes. The number of specimens examined is given in parenthesis.

equina (106) : 5 to 11 bristles ♀ ♂ (average, 7).
longipennis (143) : 3 to 7 bristles ♀ ♂ (average, 5).
fulva (3) : 8 bristles ♀ ♂.
variegata (95) : 13 to 27 bristles ♀ ♂ (average, 18).
rufipes (95) : 12 to 23 bristles ♀ ♂ (average, 17).
hirsuta (6) : 14 to 18 bristles ♀ ♂.
martinaglia (not seen).
struthionis (23) : 4 to 12 b. ♀ (average, 6) ; 8 to 15 b. ♂ (average, 10).
camelina (31) : 3 to 8 b. ♀ (average, 5) ; 11 to 22 b. ♂ (average, 14).

In *Hippobosca,* the integument of the abdomen, behind the usual large tergal and small sternal sclerotized basal plates, is mostly soft and extensible. All species I have seen have

two pairs of sclerotized subapical (lateral) plates in both sexes. In the males of *equina* and *longipennis*, the anterior pair is small and fused with the median tergal plate, yet recognized by the very long setæ it bears. In addition, these two species have in both sexes three median tergal sclerotized plates, which are much smaller in the female than in the male. Median tergal plates are lacking in both sexes of *variegata, rufipes, struthionis,* and *hirsuta,* and in the female of *camelina.* The male of *camelina,* however, has an extensive anterior sclerotized median plate, immediately behind the basal tergal sclerite of the abdomen, and posteriorly a pair of small, median tergal plates. In the female of *longipennis* and *equina* the anterior pair of subapical (lateral) plates is slightly smaller than the posterior pair; it is larger than the posterior pair in the female of *variegata, hirsuta, camelina* and *struthionis;* and both pairs are about the same size in the female of *rufipes.* In the males of *variegata, rufipes, hirsuta, camelina* and *struthionis,* the anterior pair of subapical plates is very large, the posterior pair very small and readily overlooked. I have not examined the structure of the abdomen of *fulva* and *martinaglia.*

In the male genitalia, the claspers (or parameres) are very similar in *equina, longipennis, fulva, variegata, rufipes* and *struthionis,* being more or less slender, straight and rod-like, ending in a point. In *camelina* they are of much the same rod-like type, but thicker, curved in profile and ending in a blunt, somewhat knobbed point. They are quite aberrant in *hirsuta,* being thick and beam-like, with a broadly truncate and slightly emarginate tip. The genitalia of *martinaglia* are unknown.

To sum up, the nine species of *Hippobosca* now recognized may be divided into four groups, expressing relationship based on structural characters: (1) *equina, longipennis* and *fulva;* (2) *variegata, rufipes, hirsuta* and possibly *martinaglia;* (3) *struthionis;* (4) *camelina.*

The following key supersedes that of my earlier paper (pp. 308-309). *H. martinaglia* is inserted from the description only.

1. Second longitudinal vein ($R_2 + _3$) long, about as long as or longer than last section of third longitudinal, reaching costa much beyond tip of first longitudinal

(R_1) and usually apicad of anterior cross-vein (r-m); last section of costa about three times the length of penultimate section or shorter. Base of third longitudinal vein (R_{4+5}) bare. One pair of vertical bristles. Preapical bristles of scutellum few (3 to 11). Abdomen with three median tergal sclerotized plates in both sexes (in *equina* and *longipennis;* not known in *fulva*). Two pad-like pulvilli at sides of bristle-like empodium, one much larger than the other. Parameres of male genitalia slender, rod-like, ending in a point 2

Second longitudinal vein short, shorter than last section of third longitudinal, reaching costa together with or close to tip of first longitudinal; last section of costa at least five times the length of penultimate section....4

2. Larger species, the wing 6 to 8.5 mm. long. Apical lobes of fronto-clypeus irregularly and broadly triangular, their inner margins curved. Scutellum fuscous to ferruginous laterally, yellowish-white medially, rarely more extensively yellowish; with a regular row of 5 to 11 preapical bristles (usually 6 to 8), divided into two groups. Wing veins as a rule rufous to dark brown ..... *H. equina*

Smaller, the wing at most 6 mm. long. Scutellum as a rule entirely or nearly entirely yellowish or ivory-white 3

3. Wing 5 to 6 mm. long. Apical lobes of fronto-clypeus regularly and sharply triangular, separated by a broad notch, their inner margins nearly straight. Scutellum with 3 to 7 preapical bristles (usually 5 or 6). Wing veins mostly pale testaceous, usually with some darker stretches ..... *H. longipennis.*

Wing 4.2 to 4.5 mm. long. Apical lobes of fronto-clypeus irregularly and broadly lobular, separated by a narrow slit, their inner margins curved. Scutellum with about 8 preapical bristles ..... *H. fulva*

4. Base of third longitudinal vein (R_{4+5}) setulose over some length on the upper side. One pair of vertical bristles. No median tergal plates in both sexes (in *variegata, rufipes* and *hirsuta;* probably also in *mar-*

tinaglia). Only one pulvillus well-developed, the other rudimentary 5

Base of third longitudinal vein bare 8

5. Second longitudinal vein very short, forming an oblique cross-vein which ends in the first longitudinal and runs from opposite or apicad of upper tip of anterior basal crossvein (M_3) to basad of anterior cross-vein (r-m). Frons distinctly narrower at occiput than at fronto-clypeus, the postvertex much longer than wide. Scutellum as a rule with three ivory-white spots, the largest in the center; with 13 to 27 preapical bristles (usually 16 to 20), in one or two irregular and fairly continuous rows. Parameres of male genitalia slender, rod-like, ending in a sharp point. Wing 7 to 8 mm. long ..... *H. variegata.*

Second longitudinal vein longer and more slanting, ending in costa at or beyond tip of first longitudinal and running from basad of upper tip of anterior basal cross-vein to opposite or basad of anterior cross-vein 6

6. Smaller, the wing 4.5 mm. long. Frons wide, not appreciably narrower at occiput than at fronto-clypeus, the postvertex much wider than long. Mesonotum reddish-brown, with an anterior median dark band extending posteriorly to near the transverse suture where it is more or less forked. Scutellum entirely yellowish-white; with relatively few (probably eight to ten) preapical bristles. Mesonotum moderately bristly, bare in the center ..... *H. martinaglia*

Larger, the wing 6.5 to 9 mm. long. Frons narrower, the postvertex nearly as long as wide or slightly longer. Color pattern of mesonotum different. Preapical bristles of scutellum more numerous (12 to 23) 7

7. Frons distinctly narrower at occiput than at fronto-clypeus. Scutellum very wide and nearly rectangular, with a median, rufous and two lateral, ivory-white spots; with 12 to 23 heavy preapical bristles (usually 14 to 20), placed in one regular, almost continuous row. Mesonotum moderately bristly, bare in the cen-

ter. Legs bright reddish-brown. Parameres of male genitalia slender, rod-like, ending in a blunt point. Wing 7 to 9 mm. long ..... *H. rufipes*

Frons very slightly or not narrower at occiput than at fronto-clypeus. Scutellum narrower and less rectangular, with a median ivory-white spot; with 14 to 18 soft and pale preapical bristles, placed in two irregular, more or less connected groups. Mesonotum very bristly, also in the center. Legs rufous-yellow. Parameres of male genitalia thick, beam-like, truncate and slightly emarginate at tip. Wing 6.5 to 8 mm. long ..... *H. hirsuta*

8. Two or three pairs of vertical bristles. Fronto-clypeus shorter than its distance from the occipital margin. Postvertex shorter than mediovertex, the latter much narrowed medially by the broad inner orbits. Anterior basal cross-vein (M_3) very oblique and nearly its own length from anterior cross-vein (r-m). Scutellum semi-elliptical, the hind margin distinctly convex and slightly projecting medially; in the female with 3 to 8 discal bristles (usually 4 to 6), placed in two linear groups; in the male with 11 to 22 preapical bristles (usually 12 to 15), placed in two irregular groups. No median tergal plates in the female; the male with one large median plate behind the basal tergal sclerite and a pair of small median tergal plates posteriorly. No pad-like pulvilli; bristle-like empodium bare, except at base. Parameres of male genitalia rod-like, but curved upward, the apex slightly swollen and knob-like. Wing 9 to 10 mm. long ..... *H. camelina*

One pair of vertical bristles. Fronto-clypeus nearly as long as its distance from occipital margin. Postvertex as long as or longer than mediovertex, the latter moderately narrowed by the inner orbits. Anterior basal cross-vein short, almost vertical upon the fourth longitudinal and more than twice its length from anterior cross-vein. Scutellum nearly rectangular, the hind margin more straightly truncate; in both sexes with preapical bristles placed in two widely separated lateral groups, more numerous in the male

(8 to 15, usually 9 to 12) than in the female (4 to 12, usually 5 to 7). Abdomen in both sexes without median tergal plates. Two pad-like pulvilli; empodium feathered. Parameres of male genitalia slender, rod-like, ending in a sharp point. Wing 7 to 7.5 mm. long ..... *H. struthionis*

1. *Hippobosca equina* Linnæus. — The locality "Reshadie" is near Smyrna.

Additional Specimens Examined. — Norway: Smaalenene. — Esthonia, one female off a duck, *Mergus* (or *Merganser*) *serrator* Linnaeus (sent by G. B. Thompson), an accidental host. — Finland: Kustö (C. Lundström). — Denmark: Seelland (Univ. Zool. Mus., Copenhagen). — Austria: Grünbach, Schneeberg region (Handlirsch). — Hungary. — Roumania: Bihar Mts. (K. Jordan); Herkulesbad (W. Rothschild and E. Hartert). — Bulgaria: Aladza near Varna; Bela Cerkva, Rhodope (Zerny). — Jugo-Slavia: Zljeb, New Montenegro; Stolac, Herzegovina (Penther); Bosnia. — France: Argentat, Auvergne, off a cow. — Italy: Triest; Taranto; Pola. — Corsica: Vizzavona (M. E. Mosely); Corte (M. E. Mosely); La Poce de Vizzavona (Yerbury); Ajaccio (F. Gugliemi). — Spain: Murcia (G. L. Boag); Sierra de Guadarrama, 6,000 to 8,000 ft. (B. Uvarov); Algeciras (Zerny); Noguera near Albarracin, Aragon (Zerny). — Canary Islands: La Caldera, Las Palmas Id. (W. M. Wheeler); Sa Cruz, Teneriffe; Puerto Cabias, Buenaventura. — Madeira (Lowe). — Albania: Kula Ljums; Hodzha near Prizren; Pashtrik; Korab; Durazzo. — Greece: Stavros, Macedonia (J. Waterston); Saloniki (J. Waterston); Helmas (Fonberg); Taygetos; Koystallopyghi (A. H. G. Alstoni); Attica; Poros; Vrissula; Mt. Pangaion; Struma; Carvalli (R. C. Shannon). — Asia Minor (Anatolia): Namerun; Cilician Taurus (Prince Abersperg); Sabandscha to Eskischebir; Ephesus. — Transcaucasia: Sagalu on Lake Göktschai (Zugmayer). — Turkestan. — Persia (Iran): Nissa, Elburs Mts. (Brandt); Tsiang-Kanspe, E. Persia (A. Teufigi); Enzeli, N. W. Persia (P. A. Buxton). — Arabia: Akaba, Hejaz (W. M. Mann). — Palestine: Haifa (P. J. Barraud); Beisan, Jordan Valley (P. A. Buxton). — Cyprus: Limasol (G. A. Mavromoustakis). — Egypt: Tisfa (Zool. Dept. Univ. Egypt). —

Libya: Dernah (Klaptocz). — Tunis: Gabes (Mik). — Algeria: Hamman Rirha; Hamman Meskoutine; El Kantara; Biskra (W. Rothschild and E. Hartert). — Morocco: Aguelman Sidi Ali bu Mohammed, Middle Atlas, 6,500 ft. (K. Chapman and J. W. S. Pringle); Ijoukak, Great Atlas, 3,900 ft. (K. H. Chapman and G. A. Bisset); Arround, Atlas, 1,950 m. (Ebner). — Australia: Sydney, on a horse imported from New Caledonia. — New Hebrides: Tanna Id. (E. Robertson); Vila, Efate (or Sandwich) Id., very common on horses (P. A. Buxton). — Philippines: Alabang, Rizal (M. B. Mitzmain). — Amboyna, off cattle (F. Muir). — Singapore (F. Muir).

The preapical bristles of the scutellum vary from 5 to 11 in 106 specimens examined (58 ♀ and 48 ♂), from 22 localities, 85 specimens having from 6 to 8 bristles. The specimens fall in the following groups: with 5 bristles: 3 (1 ♀, 2 ♂); 6b.: 28 (17 ♀, 11 ♂); 7b.: 22 (9 ♀, 13 ♂); 8b.: 35 (24 ♀, 11 ♂); 9b.: 10 (4 ♀, 6 ♂); 10b.: 7 (3 ♀, 4 ♂); 11b.: 1 (♂). There is no evidence of any sexual difference in this character. No locality is represented by enough specimens to make a further analysis of any significance. The bristles are evenly divided between both sides in 69 specimens, unevenly in 37, the uneven groupings observed being 2 + 3, 3 + 4, 3 + 5, 4 + 5, and 5 + 6.

The frons, in the male, is nearly parallel-sided and about as wide as an eye; in the female it is slightly widened medially, where it measures a little over the width of an eye.

In addition to the average larger number of preapical bristles of the scutellum, *H. equina* differs also from *H. longipennis* in the shape of the tergal plates of the abdomen. In the female of *H. equina*, the three median, setulose tergal plates are larger than in the female of *longipennis*, more transverse and ribbon-shaped, the median plate only slightly smaller than the hindmost plate, which is nearly as large as the anterior pair of subapical (lateral) plates. The median plates bear many more setae than in *longipennis*. In the male of *equina*, the three median tergal plates are large and ribbon-like, the hindmost (or third) plate fused with the anterior pair of ovate, widened subapical (lateral) plates (bearing longer bristles than the median plate proper). The shape and arrangement of the tergal plates

are shown correctly by Ferris (1930, Philippine Jl. Sci., XLIII, p. 540, fig. 1 ♀, and p. 543, fig. 4*a* ♂).

The claspers (or parameres) of the male genitalia are slender, rod-like and regularly pointed at apex. They are figured in side view by J. I. Roberts (1927, Ann. Trop. Med. Paras., XXI, Pl. III, fig. 8); seen from above they are much narrower.

2. *Hippobosca longipennis* Fabricius, 1805. — A study of Fabricius' two types, marked "ex Tranquebar (Mus. Dom. Lund)", at the University Zoological Museum, Copenhagen, shows that they are the species commonly known as *H. capensis* v. Olfers (1816), *H. francilloni* Leach (1817), or *H. canina* Rondani (1878). Why Fabricius wrote "Caput et thorax ferruginea immaculata" is a mystery, as both his types show the characteristic *capensis* pattern. A specimen from Kalewa, Upper Burma, named "*longipennis*" by Major Austen, was studied at the British Museum and showed no structural characters differentiating it from the usual *H. capensis*. Fabricius' name antedates all other designations for the species, which is extremely variable in color. I have also seen, at the British Museum, a specimen of *H. francilloni*, apparently labelled by Leach and which may be the type, although it is not marked as such.

Additional Specimens Examined. — Bulgaria: Sredne near Russe. — Greece: Struma (R. C. Shannon). — Transcaucasia: Sagalu on Lake Göktschai (Zugmayer). — Transcaspia: Imam-Baba, Merv District (L. Mistschenko). — Persia (Iran): Keredj, 40 Kilom. from Teheran (Brandt); Dschulfa, N. W. Persia. — Mesopotamia (Iraq): Djerabis; Assur; Daurah (A. D. Fraser); Bagdad (T. C. Connor); Amara (T. C. Connor). — Syria: Beirut (E. S. Sewell). — Palestine: Amman, E. of Jordan (P. A. Buxton). — Arabia: Ras Fartak, Hadramaut (Simony). — Cyprus: Larnaca, off cow. — Egypt: Tisfa (Zool. Dept. Univ. Egypt). — Libya: Bengasi. — Tunis: Gabès. — Morocco: Marrakesh (G. B. Fairchild). — Anglo-Egyptian Sudan: Lugud, Darfur Province (H. Lynes); Khor Arbaat, Port Sudan. — Kenya Colony: Lake Jipe; Marsabit, Rendili Nyoro (C. A. Neave); Turkana District; Merifano (McArthur); Voi (Tate); Lemek, Masai Reserve (A. O. Luckman). — Tanganyika Territory: Valley of Ruaha River, N. Uhehe; Morogoro, Uluguru (A. G. Wilkins); W. shore of

Lake Manyara (B. Cooper); Mt. Meru, off lion (B. Cooper); Ngare Nairobi, W. Kilimanjaro, 4,500 ft. (B. Cooper); Shinyanga (N. C. E. Millar). — British Bechuanaland: Ngamiland (G. D. H. Carpenter); Ghanzi, Monfalatseka, Ngamiland, off dog (J. Maurice). — India: Quetta, Baluchistan (D. Harrison); Nedungadu (P. S. Nathan); Arbham, Vizagapatam (R. Senior-White); Chipurupalle, Vizagapatam (R. S. Patuck); Kangra Valley, Punjab (Dudgeon); Dehra Dun; Bangalore; Bhowali, Kumaon, 5,700 ft. (Imms); Allahabad; Bandra (Javakar). — Ceylon: Madulsima; Banhar (R. Senior-White); Trincomali. — Assam: Mungpoo, Reang River (R. Senior-White). — Indo-China: Than-Moi, Tonkin (H. Fruhstorfer). — China: Macao (F. Muir); Tshusiung, Yunnan, 1,900 m. (Handel-Mazzetti); Tsinan, Shantung (E. Hindle); Hanchow, off dogs (Rose); Kachek, Hainan Id. (L. Gressitt); Peiping; Yen-Ping. — Manchuoko (Manchuria): Harbin (Jettmar).

The preapical bristles of the scutellum vary from 3 to 7 in 143 specimens examined (79 ♀ and 64 ♂), from 23 localities, 126 specimens having 5 or 6 bristles. The several numbers are represented as follows: with 3 bristles: 1 (♂); 4b.: 3 (1 ♀, 2 ♂); 5b.: 19 (11 ♀, 8 ♂); 6b.: 107 (60 ♀, 47 ♂); 7b. 13 (7 ♀, 6 ♂). There is apparently no sexual difference in this character. The number from any one locality is too small for further analysis. The bristles are evenly divided in 110 specimens, unevenly in 33, the uneven groups observed being 1 + 2, 2 + 3, and 3 + 4.

H. longipennis differs from *H. equina* in the shape of the tergal plates of the abdomen, the difference being more striking in the male than in the female. In the female of *H. longipennis* the three median, setulose sclerotized plates are very small, ovate or reniform, the second smaller than either the first or the third, the third much smaller than the anterior pair of subapical (lateral) plates. In the male, the three median plates are large and ribbon-like, much of the same shape as in the male of *H. equina;* but the hindmost (or third) plate is connected laterally with a pair of small, attenuated lateral subapical plates (recognizable by their bearing longer setae than the median plate proper). No adequate figures of this species have been published.

The claspers (or parameres) of the male genitalia are very similar to those of *H. equina.*

Historical Note. — There is every reason to believe that *Hippobosca longipennis*, the dog-fly of the Near and Far East, was well known by the ancient Greeks and Romans, as it is particularly abundant in the countries bordering the eastern Mediterranean. Many are the references to *"kunamuya"* (in Greek) or *Cynomya* in the classic literature and early scientific writings. Thus, in the Iliad, Ares, the god of war, upbraids Athene: "You dog-fly, why do you sow strife among the Gods? . . ." (Bk. 21, 394). Elsewhere (Bk. 21, 421) Athene exclaims: "Now watch that dog-fly [meaning Aphrodite] leading Ares through the free-for-all. . . ."[1] I am also inclined to think that the Greek word *"kunoraistai"* or dog-destroyers, used in the Odyssea (XVII, 300) and later by Aristoteles, covered the ecto-parasites of dogs in general, hippoboscid flies as well as ticks. Oudemans (1926, Tijdschr. v. Entom., LXIX, Suppl., pp. 49-59) claims that both *"kunoraistai"* and *"kunamuya"* were used by the Greeks for dog ticks only (*Ixodes reduvius* Linnaeus). He is evidently unaware of the abundance of *Hippobosca longipennis* on dogs in the Orient. It seems most improbable that the Greeks would have called a tick a fly, since they had a special word for ticks (*"krotones"*) and must have been well acquainted with both types of parasites. Moreover, the hippoboscid attracts more readily the attention and is more loathsome to the layman than the tick, owing to its habit of scurrying about in the fur and of flying from one dog to another or even onto people. Hence the use of the word "dog-fly" as a reviling or scurrilous epithet.[2]

[1]The exact dating of the collection of epic poems now called the Iliad and credited to Homer is a matter of speculation. Probably they had more or less crystallized into their present form by the eighth century B. C.

[2]Oudemans also claims that the *"muscæ"* or flies mentioned by Varro, Columella, Plinius and others as causing sores in dogs, were ticks. But in warm countries certain biting flies, such as *Stomoxys* and *Phlebotomus*, may cause true sores on the ears of dogs. Oudemans is apparently also mistaken in criticizing Albertus Magnus' use of the expression "muscæ bestiarum. quae dicuntur *cynomiæ sive muscæ caninæ*" (De Animalibus Libri XXVI, 1260). Albertus, in my opinion, alluded correctly to the winged hippoboscids which in southern Europe infest horses and cattle, as well as dogs; the two species being so much alike that laymen would naturally call them by the same name. In his second volume, Oudemans (1929, pp. 150-151) is quite elated over

Dr. Gaines Kan-chih Liu has called my attention to references to dog-flies in the early Chinese medical literature and has kindly translated some of these for my paper. In the *"Chi Tung Yeh Yu,"* by Chow Mi (who lived 1232 to 1308), one reads: "A colleague of mine, Chen P'o, of Quo Chang, is an old scholar. His grandson, when three years old, was seriously ill with fever for a week, after which *"to"* (or small-pox) broke out, the whole body turning black and the lips being icy cold. After all remedies had failed, the grandfather went to the temple to pray God for help. There he met a stranger, who, upon learning of the case, told the grandfather how to cure it. The prescription consisted of seven dog-flies, ground into a powder and taken with wine. The medicine was very effective and the child soon was in good health, the black color disappearing." In the later *"Pen Tsao Kang Mu"* (1578), by Li Shih-chen, one finds: "Dog-flies live on the body of the dog. They can fly, are yellow and fly-like and have a hard skin. They have a sharp beak and suck the blood of the dog. Formerly they were not known to be used in Medicine; but recently they have been recommended by the *Chi Tung Yeh Yu* for curing small-pox and by the *Yi Fang Da Chien* for malaria. It seems to me that they must act like the cattle-lice and the *chufoo* (or sawbugs). For malaria, the flies, after removal of the appendages, are made into pills with dough. They should be taken the morning of the day an attack of fever is due and the cure will be successful if vomiting is provoked. Another method is to make the flies into pills with wax and take the pills with wine. For small-pox and skin troubles, soak the fly in wine and then take both the fly and the wine." Finally the *"Chien Wu"* (1582), by Li Su, says: "The dog-flies deposit among the hairs of the dog their nits (puparia), which after molting become flies. They always live on the back of the neck, where they bite frequently and where the dog cannot reach them with its mouth or paws."

3. *Hippobosca fulva* Austen. — Through the courtesy of

his discovery that the Archbishop Eustace of Saloniki, in his Commentary of the Iliad, suggests that the Greek word *"kunamuya"* (which he proposes to emend to *"kunomuya"*) evidently meant the tick. But this statement proves only that the Archbishop was more proficient in philology than in natural history.

the late Major Austen, I was able to examine the holotype and paratype at the British Museum. This species, which has not been figured, is close to *H. longipennis*, the most important differences being given in the key. In addition, the vertex is somewhat narrower than in *longipennis*, with the inner margins slightly converging toward the occiput; the postvertex is shorter; the inner orbits (or parafrontalia) are narrower and of more uniform width throughout; the fronto-clypeus also narrower. The insect is mostly reddish-yellow; but scutellum, postvertex and fronto-clypeus are almost wholly pale ivory-yellow. I have seen also a male from Tanganyika Territory (West shore of Lake Manyara). This sex is almost exactly like the female. It has eight strong pale-colored preapical bristles on the scutellum (also present in both types), placed in a single row and widely divided into two groups of four each. The structure of the abdomen is not known, but is probably similar to that of *equina* and *longipennis*, with minor differences in the relative size of the median tergal plates.

In the male of *fulva* examined, the parameres of the genitalia are similar to those of *equina* and *longipennis*, but the terminal point is blunter. *H. fulva* and *H. martinaglia* are the smallest members of the genus.

4. *Hippobosca variegata* Megerlé von Mühlfeld, 1803, (actual date of publication!), Appendix ad Catal. Insect. Nov. 1802 Viennae Austriae Vendita, p. [14] (unnumbered) (Bengal).

Synonyms: *H. maculata* Leach, 1817; *H. bipartita* Macquart, 1843; *H. aegyptiaca* Macquart, 1843; *H. fossulata* Macquart, 1843;[1] *H. sudanica* Bigot, 1884; *H. sivae* Bigot, 1885; *H. calopsis* Bigot, 1885; *H. aegyptiaca* var. *bengalensis* Ormerod, 1895.

H. variegata appears to be the oldest valid name for this species, the date 1823 given by Wiedemann being erroneous (see Schenkling 1935, Arch. Morph. Taxon. Entom., Berlin-Dahlem, II, p. 156). The original description is of the briefest: "ex Beng. Aff. equin. sed maj. magisque varieg. (1 Exemplar)." Yet it is sufficient to validate the name, especially in view of the fact that Wiedemann (1830,

[1]Macquart's three names should be dated 1843, when the Mém. Soc. Sci. Lille for 1842 were actually published.

Aussereurop. Zweifl. Ins., II, p. 603) based the more detailed and fully recognizable description of his *Hippobosca variegata* in part upon Megerlé's specimen.

I have seen, at the University Zoological Museum in Copenhagen, the fly from Tranquebar mentioned by Fabricius (1805, Syst. Antliat., p. 338) as a variety of *H. equina.* It is *H. variegata* and may well have been the specimen which Wiedemann mentioned from Tranquebar. I have also seen Leach's type of *H. maculata* at the British Museum. According to the label it came from Bengal.

Additional Specimens Examined. — French West Africa: Zinder, Niger River, off cattle and horses (A. Buchanan). — Gold Coast: Salaga, N. Terr., off cattle (F. J. A. Beringer); Yegi, N. Terr.; Accra (J. W. S. Macfie); Obuasi, Ashanti (W. M. Graham). — Northern Nigeria: Kaduna (J. J. Simpson); Azare (L. Lloyd); Zungeru, off horses. — Southern Nigeria: Lagos (C. B. Philip); Olokemeji, Ibadan. — Cameroon: Bamum. — Belgian Congo: Sankuru District, 5° S., 26° E. (A. Yale Massey). — Anglo-Egyptian Sudan: Khor Hanoieit, Port Sudan; Khartoum (S. Hirst); Erkowit, Red Sea Hills, biting man (J. G. Myers); near Meshra, Equatoria biting man (J. G. Myers). — Egypt: Luxor (Reimoser.) — Ethiopia: Hawash River, W. of Mt. Zaquala, 6,000 ft. (J. O. Couper); Maraquo (O. Kovacs). — Uganda: Mt. Debasien, 5,000 ft. (A. Loveridge). — Kenya Colony: Nakuru (van Someren). — Tanganyika Territory: Kigonsera (J. N. Erth). — Natal: Durban. — Madagascar: Betsiriry District, west of S. Central Plateau, off mules (F. P. Porter); Tsaratanana, N. Central District (W. C. Holden); Ampoza (E. I. White); Tanovana, Oriental Forest District (between Tamatave and Tananarive. — C. Lamberton). — Mesopotamia (Iraq): Daurah (A. D. Fraser). — India: Calcutta (Brunetti); Bhowali, Kumaon, 5,700 ft. (Imms); Deccan (Fischer); Mukteswar, United Prov. (J. D. R. Holmes); Pusa, Bihar, off cattle (R. Senior-White); Tranquebar. — Ceylon: Banhar (R. Senior-White); Matale, off horse (R. Senior-White); Luduganga, off cattle (R. Senior-White); Habarane, off cattle (R. Senior-White); Peradenyia, off cattle (A. Rutherford); Dambula, off cattle (L. G. Saunders); Hamsantota; Madulsima; Diyawa, 4,000 ft. — Assam: Coonoor, off cattle (R. Senior-White);

Baranri (R. Senior-White). — Timor. — Celebes: Manado, off horse (F. C. Kraneveld).

The preapical bristles of the scutellum are pale-colored and unevenly developed, usually placed on two irregular rows, the two lateral groups more or less connected in the middle. Counting only the heavy bristles and neglecting the small, hair-like ones, their number varies from 13 to 27 in 95 specimens examined (49 ♀ and 46 ♂), from 12 localities, 68 specimens having from 16 to 20 bristles. The specimens show the following grouping: with 13 bristles: 2 (all ♀); 14b.: 1 (♀); 15b.: 5 (2 ♀, 3 ♂); 16b.: 7 (6 ♀, 1 ♂); 17b.: 15 (7 ♀, 8 ♂); 18b.: 15 (4 ♀, 11 ♂); 19b.: 22 (13 ♀, 9 ♂); 20b.: 9 (6 ♀, 3 ♂); 21b.: 7 (4 ♀, 3 ♂); 22b.: 2 (1 ♀, 1 ♂); 23b.: 3 (2 ♀, 1 ♂); 24b.: 4 (1 ♀, 3 ♂); 25b.: 2 (all ♂); 27b.: 1 (♂). There is seemingly no sexual difference in this character. In one lot of 30 specimens (10 ♀, 20 ♂) from Aden, off cattle, the bristles vary from 13 to 22, but 25 specimens have from 16 to 20 bristles. The bristles are evenly divided between both sides in 37 specimens, unevenly in 58, the uneven groupings observed being 6 + 7, 6 + 8, 7 + 8, 8 + 9, 9 + 10, 10 + 11, 11 + 12, 12 + 13, and 13 + 14.

In *H. variegata,* the dorsum of the abdomen bears no median tergal sclerotized plates in either sex. In the female, the anterior pair of subapical (lateral) plates is somewhat larger than the posterior pair. In the male, the anterior pair is very large, so that the two plates nearly touch medially; the posterior pair is very small and hidden in a dorsal view. The abdomen of the female is shown correctly by Ferris (1930, Philippine Jl. Sci., XLIII, p. 545, fig. 5). There is no good figure of the male.

The claspers (or parameres) of the male genitalia are straight and rod-like, rather abruptly narrowed about midlength and then very slender to the pointed tip.

5. *Hippobosca rufipes* v. Olfers.

Additional Specimens Examined. — Natal: Durban, off cattle (W. C. C. Pakes). — Cape Province: Van Rhyn's Pass (T.D.A. Cockerell); Milnertown near Cape Town (R. E. Turner); Waku (J. Bruce-Bays); Matjesfontein (R. E. Turner); Erraha (E. Gough). — South West Africa: Tsau, Great Namaqualand (Pöch); Otyivarongo, Damaraland (de

Schauensee); Windhoek to Gobabis (de Schauensee); Okahandja (R. E. Turner; J. Ogilvie); Otavifontein (K. Jordan); Usakos (J. Ogilvie); Hoffnung (K. Jordan).—Orange Free State: North Bank Halt, Norvals Poort (J. Ogilvie); Cotzies' Farm (W. L. Distant).—Bechuanaland Protectorate: Mongalatsela, Ghanzi, Ngamiland, off horse and off steinbok (J. Maurice).—Southern Rhodesia: Victoria Falls (R. Lowe Thompson).—Northern Rhodesia: Lunda, near Congo border (H. S. Evans).—Portuguese West Africa: Benguela, off cattle (W. C. C. Pakes).—Tanganyika Territory: Mt. Meru, 4,500 to 5,000 ft., off eland (B Cooper); Ngare Nairobi, W. Kilimanjaro, 5,000 ft. (B. Cooper); Ngaserai, W. Kilimanjaro, 3,000 ft. (B. Cooper).

The number of heavy, black preapical bristles of the scutellum is quite variable in this species and apparently shows no sexual difference. In 95 specimens examined (69 ♀ and 26 ♂), from 14 localities, the total number varies from 12 to 23, but 82 specimens have from 14 to 20 bristles. The specimens are distributed as follows: with 12 bristles: 2 (1 ♀, 1 ♂); 13b.: 5 (4 ♀, 1 ♂); 14b.: 10 (8 ♀, 2 ♂); 15b.: 10 (all ♀); 16b.: 7 (6 ♀, 1 ♂); 17b.: 17 (13 ♀, 4 ♂); 18b.: 18 (11 ♀, 7 ♂); 19b.: 12 (8 ♀, 4 ♂); 20b.: 8 (4 ♀, 4 ♂); 21b.: 5 (4 ♀, 1 ♂); 23b.: 1 (♂).

Most localities are represented by one or a few specimens. In a series of 67 specimens taken off cattle at Windsorton, Cape Province, the proportion is as follows: with 13b.: 3 (all ♀); 14b.: 4 (3 ♀, 1 ♂); 15b.: 9 (all ♀); 16b.: 5 (all ♀); 17b.: 12 (9 ♀, 3 ♂); 18b.: 15 (10 ♀, 5 ♂); 19b.: 8 (5 ♀, 3 ♂); 20b.: 5 (2 ♀, 3 ♂); 21b.: 5 (4 ♀, 1 ♂); 22b.: 1 (♂). The bristles are more often unevenly divided between both sides (unevenly in 58 specimens, evenly in 37), the two groups only narrowly divided, so that the row is fairly continuous. The uneven groupings observed were 6 + 7, 7 + 8, 8 + 9, 6 + 8, 7 + 9, 8 + 10, 9 + 10, 9 + 11, 10 + 11, 9 + 12, and 11 + 12.

The structure of the abdomen of *H. rufipes* is similar to that of *H. variegata*. It is correctly shown for the female by Austen (1909, Illustr. African Blood-Suck. Flies, Pl. XIII, fig. 100).

The parameres of the male genitalia are straight and

rod-like, abruptly narrowed at basal third, beyond which they are thicker than in *H. variegata* and blunter at the pointed apex.

6. *Hippobosca hirsuta* Austen. — I have seen the types of the typical form and the var. *neavei* Austen at the British Museum.

Additional Specimens Examined. — Uganda: near Lake Albert (H. Hargreaves). — Nyasaland: Akamanga, Runyinya River, N. Nyasa, off waterbuck (J. B. Davey).

The preapical bristles of the scutellum are much weaker in this species than in most other members of the genus, and pale-colored. In the few specimens seen their total number varies from 14 to 18 (1 with 14, 1 with 15, 1 with 16, and 1 with 18, for the males; 1 with 14 and 1 with 16, for the females).

The structure of the abdomen is similar to that of *H. variegata* in both sexes.

The parameres of the male genitalia differ from those of all other species of the genus. They are broad and thick, beam-like, slightly wider basally and apically in side-view. The apex is straightly truncate, shallowly and evenly emarginate, so as to produce two blunt edges, one dorsal and one ventral.

7. *Hippobosca martinaglia* Bedford, 1936, Onderstepoort Jl. Vet. Sci. An. Ind., VII, pt. 1, p. 67, fig. (on p. 68) (♀ ♂ ; off Impalla, *Aepyceros melampus* (Lichtenstein); Bar R. Ranch, Swaziland, South Africa).

In the absence of specimens, I have inserted this species in my key on the assumption that there are setæ on the basal section of the third longitudinal vein and that only one of the pulvilli is well-developed, neither character being mentioned by the author. From the figure and description, it appears to be closest to *H. hirsuta*, likewise found on antelopes. It differs in the smaller size, the few short black setae of the mesonotum, the few preapical bristles of the scutellum, the wider frons, the narrower inner orbits or parafrontalia (less than half the width of the mediovertex or frontalia), and the short, semi-elliptical postvertex. The second longitudinal vein is described as "long", but the figure shows it to be "short", reaching the costa a short distance beyond the

tip of the first longitudinal vein, so that the last section of the costa is about six times the length of the penultimate section. No median tergal plates are shown in the figure of the female. The coloration seems to fit some of my specimens of *H. longipennis* (*capensis*), but the second longitudinal vein is much shorter than in that species. The venation also separates *H. martinaglia* from *H. fulva*, a fly of about the same size, likewise found on antelopes.

The original description is reproduced, as it appeared in a periodical inaccessible to most entomologists: "A small species; length of wing 4.5 mm. Head about as wide at the occiput as at the fronto-clypeus, reddish-brown, the frontal stripe slightly darker; posterior margin of head fringed with minute, thick-set setæ, and a long seta at the base of each eye; palpi dark brown, clothed with short setae of the same colour. Thorax reddish-brown, with a median dark band extending backwards almost to the transverse suture; this band is forked posteriorly, usually more so than in the figure, and in one specimen is completely divided down the middle by a narrow line; on each side of the posterior portion of the median band there is a dark transverse band. On each side beneath the transverse suture there is a narrow transverse dark band, and beneath this a small triangular spot, which is usually indistinct and may be absent. At each latero-anterior angle there are two short setæ, one on each side slightly distad and nearer the meson; on each side above the base of the wing there are three very short, thick-set black setæ, two more similar setæ slightly above them and near the meson, and two larger setæ slightly above them and near the meson, and two larger setæ below them; on each side on the posterior margin there are five setæ. Scutellum yellowish-white, fringed with short and a few long setæ. On the venter there is a vertical dark band on each side between the fore and mid coxæ. Legs pale reddish-brown, sparsely clothed with setæ; those on the tibiæ and tarsi darker. Ungues black. Abdomen reddish-brown with numerous pale setæ. Wings hyaline with pale reddish-brown veins and short dark setæ on the costa. Second longitudinal vein (R_{2+3}) long, reaching beyond the apex of the first longitudinal vein (R_1), but not extending to the anterior cross-vein. This new species can be easily recognised

by its pale colour and dark markings on the thorax and venter between the fore and mid coxae; also by the short thick-set setæ on the thorax and pale scutellum."

8. *Hippobosca struthionis* Janson. — I have seen the type from Mt. Stewart, Cape Province, at the British Museum.

Additional Specimens Examined. — Kenya Colony: Simba, 3,350 ft.; Makumbu; Ukamba; Machakos; Athi Plains, off horse; Merifano (McArthur); Taveta, off dog (C. W. Woodhouse). — Tanganyika Territory: Tabora, off ostrich (J. Rodhain); north of Tarengere River (W. A. Lamborn); Sanga River, Muruangani. — Transvaal: Pretoria; Deelfontein; near Limpopo River, N. Transvaal, off ostrich (R. A. Cooley). — Cape Province: Philipsdale, Worcester; Hopetown; Campbell; Cradock (Miss J. Brincker); Erreha (E. Gough). — Bechuanaland: Ghanzi, Ngamiland (J. Maurice). — South West Africa: Otavi (J. Ogilvie); Aus (R. E. Turner); Greater Spitzkopje near Usakos, Damaraland (de Schauensee).

This species is unusual in that the preapical bristles of the scutellum are crowded together in two widely separated groups, placed at the extreme sides; also in that the bristles are more numerous in the male than in the female. In 23 specimens (13 ♀ and 10 ♂) examined, from 4 localities, the bristles varied in the females from 4 to 12, 9 of the 13 ♀ having from 5 to 7; in the males, from 8 to 15, 7 of the 10 ♂ having from 9 to 12. The grouping was as follows: with 4 bristles: 2 (♀); 5b.: 3 (♀); 6b.: 3 (♀); 7b.: 3 (♀); 8b.: 1 (♂); 9b.: 4 (1 ♀, 3 ♂); 11b.: 2 (♂); 12b.: 3 (1 ♀, 2 ♂); 13b.: 1 (♂); 14b.: 1 (♂); 15b.: 1 (♂). The bristles were divided into even groups in 8 specimens, unevenly in 15, the uneven groupings observed being 2 + 3, 3 + 4, 4 + 5, 5 + 6, 5 + 7, 6 + 7, and 7 + 8.

The structure of the abdomen of *H. struthionis* is similar to that of *H. variegata* in both sexes. The species has not been figured adequately.

The parameres of the male genitalia are slender, rod-like, gradually narrowed from the base to the pointed, sharp apex, and very similar to those of *H. equina*.

9. *Hippobosca camelina* Leach. — I have seen Leach's type, at the British Museum.

Additional Specimens Examined. — Morocco: Debdou-Taourirt (Ebner); Tendrara (Ebner). — Mauretania: Between Kiffa and Tidjidja, off camels (Mrs. Mary Steele). — Algeria: Biskra (Rothschild and Hartert); Ain Sefra (Rothschild and Hartert); Touggourt (Rothschild and Hartert); Oued Nça, Mzab country (Hartert); Zahrez Gharbi (Zerny). — Tunis: Gabes (Mik); Tozeur (G. F. de Witte). — Libya: Tripoli (Klaptocz); Dernah (Klaptocz); Bengasi (Klaptocz). — Egypt: Old Cairo, off horse (Efflatoun Bey); Gebel Elba, S. E. Desert (Tewfik); near Pyramids (Reimoser). — Palestine: Jericho (P. A. Buxton); Jerusalem (P. Barraud). — Arabia: Djedda (H. W. Whyte); Tuwaiq, Riyadh (H. St. J. B. Philby); Keshin (Hein). — British Somaliland: without more definite locality (C. L. Collenette). — Kenya Colony: Lodwar, Turkana; Marsabit, Rendili Nyoro, N. Frontier District (C. A. Neave); near mouth of Kallilokwelli River, Lake Rudolf (E. B. Worthington). — Anglo-Egyptian Sudan: Khor Hanoieit, Port Sudan; Erkowit, Red Sea Hills, biting man (J. G. Myers).

H. camelina is in many respects the most aberrant member of the genus, particularly in the arrangement of the scutellar bristles and in the structure of the abdomen, both features showing remarkable sexual differences. If few specimens were examined, one might be led to think that two species are confused under the name *camelina*. Fortunately I was able to study a series of 20 specimens (10 ♀ and 10 ♂), collected in one locality of British Somaliland, removing all doubt in the matter.

In the male the scutellar bristles are preapical, placed as in the other species of the genus. In 14 males examined, from 4 localities, their number varies from 11 to 22, with the following groupings: 11 bristles: 1; 12b.: 4; 14b.: 2; 15b.: 4; 16b.: 1; 17b.: 1; 22b.: 1. They are divided into two even groups in 6 males, unevenly in 8. In the female the bristles are discal, placed near the middle of the scutellum and much more spaced. In 17 females, from 6 localities, their number varies from 3 to 8, as follows: 3 bristles: 1; 4b.: 6; 5b.: 4; 6b.: 3; 7b.: 2; 8b.: 1. They are evenly divided in 10 females, unevenly in 7.

In the female the dorsum of the abdomen is entirely soft

and extensible behind the usual basal tergal sclerite; posteriorly one finds on the extreme sides two pairs of subapical strongly sclerotized plates, bearing long bristles, the anterior pair being much larger than the posterior pair. In the male there is immediately behind the basal tergal sclerite a large ribbon-like median plate, somewhat triangular medially; much farther back, also a pair of very small median plates, rather far apart; two pairs of subapical plates are present, but the posterior pair are very small and hidden from view in a dorsal aspect. The abdomen is fairly correctly drawn for both sexes by Massonnat (1909, Ann. Univ. Lyon, N.S., CXXVIII, Pl. III, figs. 24 and 25).

The parameres of the male genitalia are peculiar. They are rod-like seen from above, but in side view more or less boat-shaped; the basal two-thirds are wide, with an evenly convex lower margin; the slender apical third is curved upward and ends in a blunt, somewhat knob-like point. The outer surface is raised into a median, curved, blunt ridge, running the whole length.

NOTES ON STRUMIGENYS FROM SOUTHERN OHIO, WITH DESCRIPTIONS OF SIX NEW SPECIES

By Laurence G. Wesson, Jr., and Robert G. Wesson

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The following paper is a list, with biological notes, of 14 species of the peculiar and little known genus, *Strumigenys*, six of which are new and are here described.[1] All the material was collected within 45 miles of Jackson, which is located centrally in southern Ohio.

Strumigenys (Cephaloxys) pergandei Emery

In a previous paper[2] it was shown that *S. pergandei* lives, in southern Ohio at least, near the colonies of various other species of ants, hunting the Collembola which often abound in the nests of these other species. Since the publication of that paper, we have found *S. pergandei* on more than 30 occasions in this region, and only once was it not obviously associated with another ant. Stray workers have been found in nest galleries of *Camponotus herculeanus* subsp. *pennsylvanicus* (Degeer), *Formica fusca* (L.), and *F. truncicola* subsp. *integra* Nyl. Three workers were found in an outlying gallery of a *F. fusca* mound. The gallery led from the mound to a small kitchen midden to which the *pergandei* seemed to be going, not, as experiments have

[1]We wish to express our deep appreciation to Dr. M. R. Smith, U. S. National Museum, for his suggestions as to the relationship of several of the new forms, as well as for his loan of much cotype material for comparison.

The types of the new species are to be deposited in the collection of the Museum of Comparative Zoology, Cambridge, Mass. Paratypes, when present, will be deposited in the collections of Dr. C. H. Kennedy, Ohio State University, Columbus, Ohio, Dr. W. S. Creighton, College of the City of New York, the U. S. National Museum, Washington, D. C., the American Museum of Natural History, New York, and the authors.

[2]Wesson, L. G., Jr., Contributions to the Biology of *Strumigenys pergandei* Em., Ent. News, vol. 47, pp. 171-174 (1936).

indicated, for the debris there, but for the Collembola which lived about the refuse. Under a large, flat stone in maple woods was found a fine colony of *S. pergandei* in the center of a large *F. fusca* var. *subserica* Say colony the galleries of which surrounded the *pergandei* nest on all sides and below. Workers were observed in the galleries of about 28 additional nests of *Aphænogaster fulva* Roger under stones. Four or 5 *pergandei* workers could often be seen creeping away from the superficial galleries when a stone covering one of these nests was overturned. One such *fulva-pergandei* association was of special interest because of its similarity to the colony in the midst of the *F. subserica* nest described above. The *pergandei* were nesting in a shallow, nearly circular, earthen chamber about 3 cm. in diameter, immediately under a large, flat stone covering a colony of *A. fulva*. Large, flattened chambers and galleries of the *fulva* surrounded the *pergandei* nest for at least 8 cm. on all sides. The walls of the chamber separating the *Strumigenys* from the *Aphænogaster* were about ½ cm. thick. With one exception we have always found *S. pergandei* in the soil, that one exception being in the log mentioned below under *S. dietrichi* M. R. Smith.

Some further notes from observations of this species are recorded here. The developmental periods are approximately: egg, 15 to 16 days; larval stage, about 42 days; pupal stage, about 18 days. On 3 occasions workers were seen to bring alternately left and right forelegs to the vertex of the head, rubbing the tarsi forward and placing them on the ground. Whether this was a cleaning operation or a means of transfering some substance to the substratum, or has some other significance is not known. The ant did not clean the tarsus after rubbing the head, nor did it rub any other part of its body. Workers of different colonies fight viciously when brought together. On the other hand, a colony will adopt the brood of another colony, even of a different species of the subgenus.

Strumigenys (Cephaloxys) ornato Mayr

Two workers were found near the kitchen midden of a colony of *Aphænogaster fulva* subsp. *aquia* (Buckley) which was nesting under a large stone in a rather moist

hillside woods. Another colony was found in an almost identical situation in dense, oak woods. In the latter case a worker was first seen in a frequented gallery of *A. fulva aquia* under a large stone. The nest was located about 3 cm. to one side of the stone, and consisted of an irregular cavity, perhaps just a crack in the soil, barely beneath the humus. It contained not more than 20 workers. Both localities were in Pike County.

Strumigenys (Cephaloxys) deitrichi M. R. Smith

We have taken this ant in Pike, Lawrence, and Adams Counties. On 4 occasions workers were found under the bark of somewhat decayed logs in open, dryish woods. In all of these logs have been colonies of other species of ants, such as *Formica truncicola* subsp. *integra* Nyl., *Aphænogaster tennesseensis* Mayr, *A. lamellidens* var. *nigripes* M. R. Smith, *A. fulva* Roger, *Proceratium crassicorne* var. *vestita* Emery, *Ponera coarctata* subsp. *pennsylvanica* Buckley. One long, decayed, hickory log, covered with a tough layer of bark, was remarkable in containing colonies of at least 11 species of ants, including 5 species of *Strumigenys*. The log, lying on the edge of some woods, extended from deep shade through a clump of bushes into broken sunlight. The ant species, in approximate order from shade to sun, were: *Strumigenys deitrichi* M. R. Smith, *Ponera coarctata* subsp. *pennsylvanica* Buckley, *Aphænogaster fulva* subsp. *aquia*, Buckley, *Strumigenys pulchella* Emery, *Solenopsis molesta* (Say), *Strumigenys medialis* new species, *Strumigenys rostrata* Emery, *Proceratium crassicorne* var. *vestitum* Emery, *Lasius niger* var. *neoniger* Emery, *Strumigenys pergandei* Emery, and *Crematogaster lineolata* (Say). Several workers of *S. deitrichi* were found in the loose humus in the cedar grove described below under *S. missouriensis* M. R. Smith.

In none of these cases did we observe definite indications of an association between *S. deitrichi* and the other species of ants living near them, such as the presence of *deitrichi* workers in frequented galleries of the other.

Strumigenys (Cephaloxys) clypeata Roger

A nest of *clypeata* was found in the duff at the base of a small pine tree a few inches from a colony of *Myrmica*

punctiventris Roger. The location was on a dry sandstone bluff in Jackson County on which many colonies of *S. pergandei* had been found.[3]

Strumigenys (Cephaloxys) medialis, sp.n.

Worker: (Pl. 3, fig. 1) : Length, 2.00 mm.

Sides of head converging anteriorly, the occipital lobes posterior to the antennal insertions somewhat but not suddenly or strongly expanded; clypeus at greatest width 1/3 the length of the head exclusive of the mandibles, evenly and broadly rounded, but narrower than in *S. clypeata;* mandibles when closed 1/4 to 1/5 the length of the remainder of the head, with the stout basal teeth hidden beneath the clypeus, the succeeding toothless space very short, the apical teeth comprising 5 pair of long, acute teeth decreasing somewhat in length anteriorly, and merging without a gap into the apical series of numerous smaller teeth; posterior border of head deeply excised; antennal scapes broadly curved on the basal third; first joint of the funiculus distinctly shorter than the fourth, the terminal joint slightly longer than the remainder of the funiculus. Thorax as in *S. clypeata;* the dorsum of the mesonotum somewhat flattened, not marginate laterally; mesoepinotal suture distinct but not constricted; epinotal spines acute, slightly divergent, directed backwards; infraspinal lamellæ narrow, uniform in width. Petiole, postpetiole and gaster as in *S. clypeata* and related species.

Head, thorax and petiole coarsely and densely reticulate-punctate, opaque; meso- and metapleura, dorsal surface of postpetiole and gaster smooth and shining; first gastric segment with numerous coarse longitudinal striae on the basal 1/3; sculpture of the clypeus much finer than the rest of the head, densely and finely crenulate-punctate, subopaque. Hairs on the clypeus numerous, erect, anteriorly curved, narrowly squamose at their tips, those on the sides 1/5 the width of the clypeus, those in the middle somewhat shorter; hairs on the rest of the head sparse, longer, thin, clavate, 1 or 2 on each side of the head very long and not clavate. Hairs on antennal scapes numerous, similar to those on the vertex of the head, curved toward the tip of the scapes;

[3]Wesson, L. G., Jr., Contributions to the Biology of Strumigenys pergandei Em., Ent. News, vol. 47, pp. 171-174 (1936).

hairs on thorax irregular, long, thin, not clavate, the majority subappressed; gaster bearing 2 or 3 long hairs, usually near the base, a number of shorter hairs at the tip. Spongiform processes as in *S. clypeata* and related species.

Color dark ferruginous, the appendages slightly lighter, the gaster darker.

S. medialis possesses the general characteristics of *S. clypeata* and the species related to it. It may readily be separated from other forms, however, by (1) the longer mandibles, which are ¼ to ⅕ the length of the head; (2) the more narrowly rounded clypeus, the surface of which is subopaque; (3) the pilosity of the clypeus, the hairs of which are longer, erect, feebly squamose and sharply curved apically, and (4) generally by the pilosity of the rest of the head and antennal scapes.

Type locality: Beaver, Pike County, Ohio.

Described from a colony of about 30 workers and several dealate females taken from the hickory log described above under *S. deitrichi.* The nest consisted of irregular cavities in the outer rotten portion of the log which appeared to be old galleries of beetle larvae. The colony was transferred to an artificial nest where, as did other species of *Strumigenys* we have had under observation, they fed on living springtails. In their hunting they were quite inactive, even more so than *S. pulchella;* the workers would remain in a crouching position, head close to the substratum, mandibles closed, antennae partially folded, for a great deal of the time. Occasionally some of the dealate females were observed hunting like the workers. Otherwise the hunting methods of this species resembled those of *S. pergandei.*

Strumigenys (Cephaloxys) bimarginata, sp. n.

Worker: (Pl. 3, fig. 2) : Length, 1.7 mm.

Head, exclusive of mandibles, 3.3 times the greatest width of the clypeus, 5.7 times the length of the exposed portion of the closed mandibles. Viewed anteriorly, the sides of the head anterior to the antennal insertions are straight, converging, their projections lying along the exterior border of the closed mandibles; clypeus rather narrow but evenly rounded, not acute, flattened dorsally; clypeus viewed from

the side with its edge broadly and deeply grooved along the entire lateral and anterior borders, thus giving the clypeus the appearance of having 2 margins, a thin but narrow upper margin and a thicker broader lower margin which projects beyond the upper margin and is visible when the clypeus is viewed anteriorly. Mandibles rather slender and elongate, the exterior border straight basally, feebly convex apically; basal tooth stout, partially concealed by the clypeus when the mandibles are closed; succeeding toothless space very short; apical teeth comprising 7 or 8 large irregular teeth which decrease in size anteriorly to merge into the apical series of numerous small teeth. Antennal scapes broadly curved basally, not angulate, fourth funicular joint slightly longer than the first; terminal joint slightly longer than the remainder of the funiculus. Sides of head posterior to the antennal insertions suddenly expanding to a broadly circular border so that that portion of the head appears subglobose when viewed anteriorly. Posterior border narrowly and rather deeply excised. Thorax essentially as in *S. clypeata;* mesoepinotal suture distinct but not constricted; median longitudinal carina prominent, especially on the basal surface of the epinotum. Petiole, postpetiole and gaster as in *S. clypeata.*

Head, thorax and petiole densely reticulate-punctate, subopaque; vertex of head with 8 or 10 broken irregular longitudinal rugae. Mandibles, clypeus, sides of mesonotum, meso- and metapleura, dorsum of the postpetiole and gaster smooth and shining; basal ¼ of the first gastric segment with numerous coarse longitudinal striae.

Hairs on clypeus sparse, long, erect, more numerous on the edges, each hair being fairly straight at the base, curved and slightly enlarged on the apical ⅓, ¼ to ½ the width of the clypeus; hairs on vertex numerous, shorter, erect, clavate, curved anteriorly; antennal scapes with numerous hairs similar to those on the vertex but less clavate, curved toward the tips of the scapes; hairs on the thorax, petiole and postpetiole numerous, variable, those on the thoracic dorsum being rather long, slightly clavate, appressed, those on the petiole and postpetiole averaging longer, more erect and not clavate; gaster with sparse, long, slender, erect hairs. Spongiform processes as in *S. clypeata* and related species.

Color ferruginous; mandibles, antennae and legs slightly lighter; gaster darker.

This very distinctive species is readily recognized by (1) the doubly margined character of the clypeal border; (2) the smooth and shining surface of the clypeus, and the more extensive shining areas on the thorax; (3) the shape of the head (4) the pilosity of the head.

Type locality: Cedar Mills, Adams County, Ohio.

Described from a single worker found under a piece of bark lying on the ground in a somewhat open, grassy spot in rather brushy cut-over woods. A deälated female belonging to this species was found about 15 cm. distant in some thin, vegetable debris. Further search failed to reveal any more specimens.

Strumigenys (Cephaloxys) manni, sp. n.[4]

Worker: (Pl. 3, fig. 3) : Length, 1.8-2.0 mm.

Head 2.5 times as long as the greatest width of the clypeus, 1.3 times the greatest width across the occipital lobes; viewed anteriorly, the sides of the head anterior to the antennal insertions are gently convergent, slightly convex, in outline merging without definite change of slope with the exterior borders of the mandibles; clypeus with lateral borders gently convergent, nearly straight, the anterior border truncate at, or a little anterior to, the point of intersection of the lateral and external mandibular borders; in some specimens, the anterior border is slightly emarginate, in others it is somewhat angularly convex in the middle, but the truncate appearance is not lost. Occipital lobes expanding suddenly but not strongly from the anterior portion of the head, at first broadly convex, then more strongly convex as the posterior border is approached; posterior border rather broadly and moderately excised. Mandibles ¼ the length of the rest of the head, rather robust, the external border broadly and evenly convex; basal teeth very broad and short, partially concealed by the clypeus when the mandibles are closed, followed without an intervening toothless space by 5 pairs of moderately long acute teeth, the third

[4]It gives us pleasure to name this distinctive species after Dr. W. M. Mann, from whom we have received many kind favors.

pair somewhat longer than the others, these acute teeth followed by the apical series of several much smaller teeth. Eyes small, comprising 10 or 12 facets. Antennal scapes $\frac{3}{5}$ the length of the funiculi, rounded but not angulate on the basal third; fourth joint of the funiculus very slightly shorter than the first, terminal joint as long as the remainder of the funiculus. Thorax as in *S. clypeata*, humeri and lateral margins smoothly rounded, somewhat flattened on the dorsum of the mesonotum, mesoepinotal suture distinct, slightly constricted; epinotal spines acute, thin; infraspinal lamellae narrow, not expanded ventrally. Node of petiole in profile rather prominent, broadly convex, the anterior slope rising suddenly but gently from the peduncle, the posterior slope declining very distinctly to the junction with the postpetiole.

Head, thorax and petiole reticulate-punctate, subopaque; mandibles, meso- and metapleura, dorsum of the postpetiole and gaster smooth and shining; first gastric segment with numerous, coarse, longitudinal striae on the basal $\frac{1}{5}$.

Hairs on head and thoracic dorsum numerous, moderately long, thin, curved and somewhat clavate at their tips; those on the clypeus shorter, curved laterally and anteriorly, a few on the borders of the clypeus slightly longer, curved posteriorly; hairs on antennal scapes erect, clavate on the anterior edge, more numerous and thinner dorsally, deflected toward the tips of the scapes; hairs on the thorax more irregular in length and distribution, and less clavate; hairs on the petiole, postpetiole and gaster very long, thin, very few on the gaster.

Color, light to dark ferruginous; tarsi and antennal funiculi slightly paler; gaster darker.

Type locality: Pike County, near Sinking Spring, Ohio.

Described from 32 workers obtained by sifting dirt and humus in the small cedar grove described below under *S. missouriensis*. The spot was situated at the base of a hill where the soil above the underlying limestone was only 5 to 8 cm. deep. The ground was shaded by cedar and small oak trees and was covered with a rather thick, loose humus abounding with springtails.

In shape of the head, *S. manni* bears a superficial resemblance to *S. margaritæ* Forel, but differs from that form in

characters too numerous to mention. It is distinguished generally by (1) the decidedly truncate appearance of the clypeus; (2) the long and robust mandibles; (3) the mandibular dentition; (4) the relative prominence of the node of the petiole; (5) the character of the pilosity of the head and thorax; (6) the shorter terminal joints of the antennae.

Strumigenys (Cephaloxys) rostrata Emery

Jackson, Pike, Ross and Scioto counties.

We have taken this species in both soil and wood, sometimes in decidedly dry situations. Three colonies were found respectively in the hickory log mentioned under *S. deitrichi*, the decaying portion of a large elm tree in which also lived a colony of *Aphaenogaster tennesseensis* Mayr, and in a crevice in a stump in a wooded pasture, a few centimeters from another colony of *A. tennesseensis*. 3 colonies were taken on the edge of some dry oak woods, all in or on the humus just under the dry oak leaves, which, with some grass and herbs, covered the ground. The nesting site of one was a rotten hickory nut; the second was in some cavities in a small decayed stick; the third was living in a crevice of a partly buried board. Workers were found under the leaves in the vicinity of the nests, presumably foraging. They were not apparently associated with any other ants. A few dead springtails were found in one of the nests. On one occasion a colony of *rostrata* was found living in a chamber in dry soil under a stone. Under the stone there also ran a few galleries of *Lasius umbratus mixtus* var. *aphidicola* (Walsh).

A *rostrata* colony was transferred to an artificial nest for observation. While employing the same general methods of hunting springtails as the other species studied, the *rostrata* workers differ in being more active. Instead of crouching in one spot awaiting the advent of a springtail, they spend most of their foraging time moving over the debris in the nest. When a worker scents a springtail 2 or 3 mm. away, she crouches, and, without touching it, tries various avenues of approach until she is so close that her mandibles almost touch the springtail. Then, head lowered,

mandibles closed, antennae partially folded, she waits until the springtail, unaware of her presence, walks against her head. Then, seizing it with a quick snap of her mandibles, she quickly dispatches it with her sting. If, on the other hand, the springtail moves away from the ant, the latter repeats her approach. If the springtail shows no inclination to move within a few minutes, the ant often acts as though impatient, and tries to examine it with her antennae, or to take it in her mandibles.

Strumigenys (Cephaloxys) pulchella Emery

We have found this species on about 15 occasions, each time in dead wood. A typical habitat seems to be a log or stump or dead portion of a tree trunk, well-decayed for 3 or 4 cm. beneath the bark, moist but not wet, warm but not in full sun. Such desirable situations are almost always inhabited by species of *Aphænogaster, Lasius niger* var. *americanus* Emery, or *Camponotus herculeanus pennsylvanicus* var. *ferrugineus* (F.). Whether *S. pulchella* is definitely associated with the other species, as is *S. pergandei,* or whether it is simply a matter of such a situation being a very favorable one for other reasons, we have not determined. Although we have seldom taken *pulchella* workers in the frequented galleries of other ants, the colonies have seemed to be much more definitely associated with a larger species than chance alone would account for.

Several times when logs and stumps were broken open *pulchella* workers were seen carrying dead springtails in their mandibles, and when kept in an artificial nest they readily captured and killed these insects. They would, however, accept bits of dead flies after having been starved for a few days. Their hunting methods are similar to those of *S. pergandei,* but the workers are less active. They walk less around the galleries and amid the woody debris provided them and often crouch for hours at a cranny. When a springtail approaches, the worker merely lowers its head, turns in the direction of the quarry and waits. Only when the springtail touches the fore part of its head and mandibles does the *pulchella* snap and seize it. Once a dead springtail was gently pushed close to a waiting *pulchella* worker. The latter crept up to about the length of its head away, then crouched, holding its antennae partially folded.

After waiting in this position for a considerable time, it rose, extended its antennae and vibrated them rapidly, then crouched again. This was repeated two more times before the ant, as if impatient after ¾ of an hour, walked up to the springtail and seized it.

Winged phases were taken from nests in mid August.

Strumigenys (Cephaloxys) missouriensis M. R. Smith

Four colonies and numerous stray workers were found in a cedar thicket in western Pike County. The first workers were seen in and around some little-used gallaries of *Aphænogaster fulva aquia* var. *picea* Emery under a small stone, and the colony was located about 30 cm. away just beneath the humus. Two other colonies were likewise in the soil, not more than 4 cm. below the surface. The latter, however, were not visibly associated with any other ants. Scattered, stray workers were found just under the top layer of the humus. The cedar grove was located on the gently sloping base of a hill. Mingled with the cedars were a few small oaks and an occasional maple sapling. The soil was a black clay from 5 to 15 cm. deep above the limestone bed rock. Above the clay was a thick, springy layer of loose decaying cedar needles, leaves and grass. Abounding in this debris were *Ponera coarctata* subsp. *pennsylvanica* Emery, *Myrmecina graminicola* (Latr.) subsp. and hordes of Collembola, as well as *Strumigenys*. Here, in an area of 3 by 9 meters, were found *S. missouriensis* M. R. Smith, *S. manni* new species, *S. deitrichi* M. R. Smith, and *S. venatrix* new species.

On careful comparison of our specimens with 2 worker cotypes loaned by Dr. M. R. Smith, we find that, although some of the workers agree closely with the cotypes, there is quite a perceptible amount of variation both among workers from the same colony and among the 4 colonies found. This variation lies almost entirely in the direction of forms which differ from the cotypes in the following details: (1) the head is slightly more robust; (2) the clypeus is slightly depressed in the middle; (3) the antennal scapes are somewhat more angulate; (4) the sculpture is distinctly coarser; (5) the hairs on the head are larger, especially on the clypeus, and are fewer in number.

Strumigenys (Cephaloxys) reflexa, sp. n.

Worker: (Pl. 3, fig. 4) : Length, 1.75-1.85 mm.

Head robust; exclusive of mandibles, 2 to 2.2 times as long as the greatest width of the clypeus, 1.3 times the greatest width across the occipital lobes; clypeus broadly rounded laterally, more narrowly rounded in the middle of the anterior border, the sides strongly scalloped; anterior portion of the head with a very broad distinct depression extending from the anterior portion of the clypeus to between the frontal carinae; occipital lobes broadly and rather evenly rounded; posterior border shallowly excised. Mandibles 1/6 the length of the rest of the head, moderately robust, the external borders gently convex; the pair of basal teeth stout, just hidden when the mandibles are closed, succeeded by a toothless space which is equal to 1/3 the length of the mandibles anterior to them, the toothless space followed by 4 or 5 pairs of rather short acute teeth which meet the apical series of numerous fine denticles. Antennal scapes rather sharply but not strongly angulate basally, 2/3 as long as the funiculi; fourth funicular joint decidedly shorter than the first, the terminal joint almost half again as long as the remainder of the funiculus.

Thorax as in *S. puchella;* mesoepinotal suture distinct, slightly constricted. Epinotal spines broad and thin; infraspinal lamellæ wide, broadly expanded ventrally.

Head, thorax and petiole reticulate-punctate, subopaque; head, especially on the dorsal posterior half coarsely tuberculate. Meso- and meta pleura, dorsum of the postpetiole and gaster, smooth and shining; first gastric segment with numerous coarse longitudinal striae on the basal 1/4.

Clypeus with a few, short, irregular squamose hairs on the border; projecting from the edge of the clypeus on each side are 3, occasionally 4, long coarse squamose hairs which are strongly curved posteriorly; the rest of the dorsal surface of the head with more numerous erect, curved, narrow squamose hairs, curved predominately posteriorly; antennal scapes with 6 or 8 erect, clavate hairs on the outer border, most of which are slightly curved toward the bases of the scapes. Hairs on thorax sparse, irregular in length, erect, slightly enlarged apically. Petiole, postpetiole and gaster

with long thin erect hairs, slightly enlarged apically. Legs and antennal funiculi with thin reclinate hairs. Spongiform processes as in *S. pulchella.*

Color ferrugineus; the gaster, darker.

Type locality: Jackson, Ohio.

We have compared *S. reflexa* with cotypes of *S. missouriensis* M. R. Smith and *S. sculpturata* M. R. Smith to both of which it is very similar. From *S. missouriensis* it may be distinguished by (1) the broad depression on the anterior portion of the head; (2) the much more strongly scalloped and sculptured head; (3) the less convex mandibles; (4) character of the pilosity. From *S. sculpturata* it differs in (1) the more robust head; (2) the rounded, non-truncate clypeus; (3) the slightly less abundant pilosity, particularly on the clypeus and gaster; (4) the appearance of the 6 large fringing clypeal hairs which are curved strongly backward —a feature by which this form may be easily recognized.

A colony of this species was found in a small, punky, partly-buried board in moderate shade in a backyard in Jackson. The colony was within a meter of a large log pile, and workers were found foraging among the woody debris at the base. Stray workers were discovered at 2 other places in the yard. An early attempt to find the above colony gives a check on the feeding habits of the species. A dead springtail was placed in front of a worker which had been discovered beneath a piece of bark. Apparently not greatly disturbed, the ant continued to stalk among the debris until she came within about 1 mm. of the springtail. She then crouched and waited. After several minutes, the springtail was gently pushed toward the ant until it was partly on top of her head. The next instant the ant was to be seen holding the already dead springtail tightly in her mandibles and stinging it viciously. In a few seconds she started off at a rapid pace with the springtail. In the artificial nest the hunting methods of the workers were similar to those of *S. pulchella,* but even more sluggish.

Strumigenys (Cephaloxys) venatrix, sp. n.

Worker: (Pl. 3, fig. 5) : Length, 1.8-2.0 mm.

Head relatively slender, exclusive of the mandibles, 2.7 times the width of the clypeus, 1.4 times the greatest width

across the occipital lobes; anterior portion of the head as viewed from the front slightly but perceptibly converging; clypeus with sides converging gently on the basal ⅔, the anterior border very broadly rounded, somewhat flattened in appearance, but definitely not truncate; the dorsal surface evenly convex, the edges with very small, inconspicuous scalloping; the occipital lobes very broadly convex anteriorly, more strongly convex as the posterior border is approached; posterior border broadly and rather deeply excised. Mandibles somewhat less than ⅕ the length of the head alone, rather slender, the external borders gently convex; basal teeth stout, partially concealed by the clypeus when the mandibles are closed, followed by a toothless space ⅓ the length of the mandibles anterior to the basal teeth, the toothless space terminated by 4 or 5 pair of acute teeth somewhat irregular in length, but longer basally, which meet the apical series of smaller irregular denticles. Antennal scapes moderately curved, not angulate basally, about ⅗ the length of the funiculi; fourth funicular joint slightly longer than the first, terminal joint slightly longer than the remainder of the funiculus. Thorax similar to that of *S. pulchella;* with a distinct and somewhat constricted mesoepinotal suture. Epinotal spines moderately broad and thin; infraspinal lamellae moderately broad, not or very slightly expanded ventrally. Petiole in lateral profile with node rather low but broad, the anterior slope rather short.

Head, thorax and petiole reticulate-punctate, subopaque, the reticulations, especially on the mesonotum, tending to form faint longitudinal rugae. Meso- and metapleura, dorsum of the postpetiole and gaster smooth and shining. First gastric segment with numerous coarse longitudinal striae on the basal ⅓.

Hairs on the clypeus short, subappressed, moderately squamose; the sides of the clypeus bearing a fringe of 10 or 12 anteriorly curved hairs on each side, the hairs occurring as pairs, one hair in each pair long, very narrowly squamose, the others, arising medially to the first, shorter and more squamose; hairs on antennal scapes comprising 5 or 6 moderately long, narrowly squamose hairs on the external border curved toward the tips of the scapes, and in addition numerous thin, straighter, subappressed hairs. Thorax

with sparse, moderately long, thin, reclinate hairs. Petiole, postpetiole and gaster with sparse, long, thin, curved, erect hairs. Legs with thin, moderately long, reclinate hairs. Spongiform processes approximately as in *S. pulchella.*

Color ferrugineus; gaster darker.

Type locality: Kitts Hill, southern Lawrence County, Ohio.

Similar to *S. pulchella* Emery and *S. creightoni* M. R. Smith. From *S. pulchella, S. venatrix* differs in (1) the narrower anterior portion of the head, and correspondingly a proportionately wider posterior portion; (2) the differently shaped clypeus; (3) the longer mandibles; (4) the different pilosity, particularly on the head. From *S. creightoni,* which it closely resembles in the shape of the head and mandibles, *S. venatrix* differs in (1) its entire and rounded clypeal borders; (2) the very different pilosity, especially on the vertex of the head and on the thorax.

Described from a colony containing about 60 workers.

Eight colonies and occasional scattered workers have been taken in Pike, Lawrence, Scioto and Adams Counties. The species is definitely a soil or humus dweller and forages for Collembola under the leaves and dead vegetable matter on the surface of the ground. So far as we can tell, it is not associated with other species for the purpose of obtaining the Collembola about their nest. Specific examples of the colonies may give a better idea of the habitus. A colony was found in a small opening near the edge of some young oak woods on a rather dry, gently-sloping hillside. The soil was a sandy clay. Several workers were first observed around a light cover of dead leaves. One of these, carrying a springtail in its mandibles, led to the nest, the entrance of which, was a tiny hole under a flake of stone in the middle of a small bare area 30 sq. cm. in extent. Just below the surface, this hole widened out into a spacious, elongate chamber 5 to 10 mm. in diameter and 10 cm. in length, which appeared to be the hollow interior of a dead and decayed root. Another colony was found in the grassy humus on the edge of a bushy thicket in a field. A colony of *Aphaenogaster fulva* was under an adjacent stone. Four colonies, including the type, were found in a grassy clearing in some dry, open woods. Two of these colonies were on the surface in the

tangled roots of the grass, while the other 2 were in the soil 2 to 8 cm. below the surface. Galleries of *Camponotus castaneus* subsp. *americanus* Mayr ran close to one nest, but we were unable to find any connection between the two. Two colonies were found in the cedar thicket described above under *S. missouriensis*. One of these was nesting in an opening at the bottom of the humus, the other in a small cavity at the base of an old rotted cedar stump. Stray workers in these and other places were often found by pulling back the top cover of the humus in places where springtails were abundant.

Strumigenys (Cephaloxys) abdita, sp. n.

Worker: (Pl. 3, fig. 6) : Length, 2 mm.

Head, exclusive of mandibles, 1.3 times as long as the greatest width across the occipital lobes, 2.4 times as long as the greatest width of the clypeus; sides of anterior portion of head very slightly convergent; clypeus short and broad, the anterior border strongly flattened or truncate but not so as to make the head appear sharply rectangular; mandibles rather long and slender, compressed dorso-ventrally, ¼ - ⅕ the length of the head alone, the internal border nearly straight, the external border straight on the basal half, gently convex on the apical half; mandibles with a pair of large basal teeth partially concealed by the clyeus when the mandibles are closed; basal teeth followed by a toothless space ⅓ the length of the portion of the mandibles anterior to them; terminal teeth comprising a compact row of 4 or 5 pair of large acute teeth, the second largest, the rest decreasing somewhat in length anteriorly, meeting and merging with little interruption into the apical series of a number of small teeth on the deflected tip of the mandibles; antennal scapes slightly angulate basally; first joint as long as the fourth; terminal joint 1¼ times as long as the rest of the funiculus. Humeri prominent, broadly angulate; median dorsal carina of thorax obsolescent; prominent lateral carinae present on base of epinotum terminating in the epinotal spines; epinotal spines somewhat longer than broad at the base, acute, flattened; infraspinal lamellae moderately wide dorsally, each suddenly expanding ventrally into a wide,

rounded plate; mesoepinotal suture distinct, slightly constricted. Node of petiole in profile rather strongly convex above.

Head, thorax and petiole reticulate-punctate, subopaque, the sculpture on the clypeus decidedly finer than on the rest of the head; frontal area, sides of the mesonotum, meso- and metapleura, dorsum of the postpetiole and gaster smooth and shining, first gastric segment with numerous coarse longitudinal striae on the basal ⅓.

Hairs on the clypeus numerous, moderately long, somewhat irregular, erect, the tips spatulate and curved horizontally, numbering about 30 on the dorsal surface, the border with 10 or 12 similar hairs curved anteriorly, the whole effect giving the clypeus a woolly appearance when viewed under low magnification. Pilosity of the rest of the head sparser, more curved and narrowly squamose; across the posterior border of the head is a transverse row of 4 evenly spaced, very long, thin, erect hairs; although 1 or 2 of these is sometimes missing, the position of the others is not altered. Antennal scapes with 5 or 6 irregular, moderately long, erect, narrow, squamose hairs on the external border, 4 or 5 similar but much shorter hairs on the dorsal surfaces. Thorax with sparse, moderately long, clavate, subappressed hairs and 1 or 2 much longer erect, thin hairs confined principally to the dorsum of the mesonotum. Node of petiole with numerous rather short, curved, blunt or clavate hairs. Postpetiole and gaster with very few long, slender, nearly straight hairs.

Color ferruginous; gaster darker.

Type locality: Jackson, Ohio.

Described from 3 workers found under a board and pieces of slate in a shaded spot in a backyard in Jackson. We did not succeed in locating the colony. It may be noted that of the 4 species of *Strumigenys* (*pergandei, rostrata, reflexa, abdita*) found in this yard, 2 were undescribed.

In order to facilitate the separation of the 6 new forms described above, we have modified Smith's key[5] to include

[5]Smith, M. R., 1931, Revision of the Genus Strumigenys of America North of Mexico, Based on a Study of the Workers, Ann. Ent. Soc. Amer., 24, pp. 686-710.

them, as well as several other species described[6] since the publication of Smith's paper.

Key to Workers of Strumigenys, subgenus Cephaloxys of the United States.

1. Dorsal surface of first gastric segment clearly shagreened, subopaque; infraspinal lamella absent .... *margaritæ* Forel.

   Dorsal surface of first gastric segment smooth and shining; infraspinal lamella present 2

2. Prothorax not only flattened, but also very strongly marginate laterally; head almost destitute of pilosity except for a pair of short, more or less erect, club-like hairs on the vertex. .... *membranifera simillima* Emery

   Prothorax not as above; head covered more or less abundantly with varied types of pilosity 3

3. Sides of head as viewed from the front evenly and smoothly converging to the apices of the mandibles. 4

   Sides of head subparallel or only slightly converging; external border of mandibles not lying on an anterior projection of the sides of the head 15

4. Clypeus very acute anteriorly; clypeal hairs few, long, erect, thickened, confined principally to the median anterior portion of the disk .... *deitrichi* M. R. Smith

   Clypeus distinctly not as above 5

5. Clypeus smooth and shining 6

   Clypeus opaque or subopaque 8

6. Clypeal hairs short, curved, apically enlarged .... *brevisetosa* M. R. Smith

[6]Kennedy, C. H., and Schramm, M. M., 1933, A New Strumigenys with Notes on the Ohio Species, Ann. Ent. Soc. Amer., 25, pp. 95-104. (*S. ohioensis*)

Weber, N. A., 1934, A New Strumigenys from Illinois, Psyche, 41, pp. 63-65. (*S. talpa*)

Smith, M. R., 1935, Two New Species of North American Strumigenys, Ann. Ent. Soc. Amer. 28 pp. 214-216. (*S. rohweri, S. brevisetosa*)

Clypeal hairs long, ½ to ⅓ times the width of the clypeus 7

7. Edge of clypeus in profile entire; clypeal hairs straight, thin, abundant; hairs on vertex sparse, hardly clavate ..... *clypeata* var. *laevinasis* M. R. Smith

Edge of clypeus in profile deeply grooved; clypeal hairs sparse, curved, slightly enlarged apically; hairs on vertex numerous, shorter, clavate (Pl. 3, fig. 2) ..... *bimarginata* sp. n.

8. Clypeus with a few, long hairs, very much enlarged apically and principally on the anterior portion of the disk and also a pair of long, thick, recurved, but not suddenly enlarged hairs, posteriorly *ornata* Mayr

Clypeal pilosity distinctly not as above 9

9. Clypeal hairs straight, imperceptibly or not at all enlarged 10

Clypeal hairs curved, distinctly clavate or squamose 11

10. Clypeal hairs short, not over ⅛ as long as the width of the clypeus ..... *ohioensis* Kennedy and Schramm

Clypeal hairs long, ⅓ to ½ the width of the clypeus..... *pilinasis* Forel

11. Clypeal hairs short, squamose, appressed 12

Clypeal hairs longer, more or less erect, clavate or narrowly squamose 13

12. Clypeus broadly and evenly rounded; the surface in large part concealed by the squamose hairs ..... *clypeata* Roger

Clypeus very broadly rounded, appearing somewhat truncate; clypeal surface almost entirely concealed by the spatulate hairs ..... *rohweri* M. R. Smith

13. Clypeus rather sharply truncate in appearance; mandibles ¼ the length of the rest of head (Pl. 3, fig. 3) ..... *manni* sp. n.

Clypeus broadly rounded, not truncate; mandibles shorter 14

14. Head broader; mandibles less than ⅕ the length of the rest of the head; posterior border of head shallowly excised; toothless space of mandibles distinct ..... *talpa* Weber

Head narrower; mandibles slightly more than 1/5 the length of the rest of the head; posterior border deeply excised; toothless space of mandibles small and indistinct. (Pl. 3, fig. 1.) ..... *medialis* sp.n.

15. Mandibles longer, 1/3 the length of the rest of head, clypeus truncate or emarginate or very broadly flattened anteriorly 16

Mandibles shorter; clypeus variable 17

16. Clypeus decidedly truncate anteriorly, thus giving the head a subrectangular appearance; antennal scapes not only short but very strongly angulate basally ..... *angulata* M. R. Smith

Clypeus, although moderately truncate anteriorly, not enough to give a decidedly subrectangular appearance to the head; scapes longer and less angulate basally ..... *pergandei* Emery

17. Clypeus truncate or subtruncate in front 18

Clypeus broadly rounded in front 21

18. Mandibles with large coarse teeth on their entire inner borders; clypeus broadly truncate or slightly emarginate ..... *rostrata* Emery

Mandibles toothed on only a part of their inner border; clypeus truncate but never emarginate 19

19. Mandibles longer, 1/4 to 1/5 the length of the rest of head; clypeus very short and broad, the sides gently convergent (Pl. 3, fig. 6) ..... *abdita* sp.n.

Mandibles shorter, 1/6 the length of the rest of head; clypeus longer, the sides more strongly convergent 20

20. Hairs on head rather abundant, distinctly squamiform ..... *creightoni* M. R. Smith

Hairs on head less abundant, longer, and, although slightly enlarged apically, not squamiform ..... *sculpturata* M. R. Smith

21. Sides of anterior portion of head gently and evenly convergent to the very broadly rounded clypeus; mandibles nearly 1/5 the length of the rest of head Pl. 3, fig. 5) ..... *venatrix* sp.n.

Sides of anterior portion of head parallel, the clypeus evenly and broadly and broadly rounded on its entire border; mandibles shorter 22

22. Clypeus decidedly depressed in the middle, the sides strongly scalloped, each side with 3 large, erect, squamose hairs which are curved posteriorly; head robust; mandibles somewhat convex (Pl. 3, fig. 4) ..... *reflexa* sp.n.

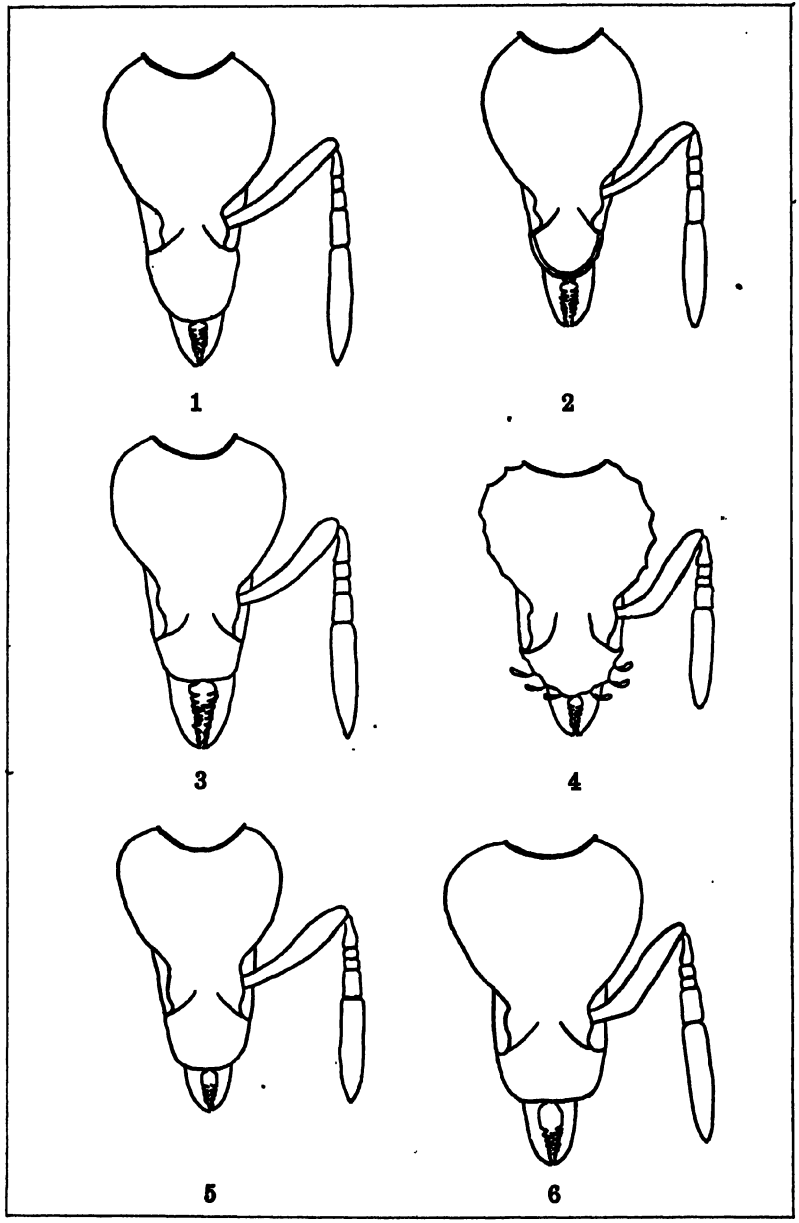
Clypeus not as above 23

23. Head relatively robust in proportion to its length; upper half rugulose or tuberculate; mandibles robust, convex ..... *missouriensis* M. R. Smith

Head relatively slender in proportion to its length; surface, although reticulate-punctate, not tuberculate; mandibles slender and somewhat laterally compressed ..... *pulchella* Emery

Legend for Plate III.

Fig. 1. *Strumigenys medialis* sp. n., head of worker.
Fig. 2. *Strumigenys bimarginata* sp. n., head of worker.
Fig. 3. *Strumigenys manni* sp. n., head of worker.
Fig. 4. *Strumigenys reflexa* sp. n., head of worker.
Fig. 5. *Strumigenys venatrix* sp. n., head of worker.
Fig. 6. *Strumigenys abdita* sp. n., head of worker.



Wesson — Strumigenys

PSYCHE

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A KEY TO THE MOSQUITOES OF MASSACHUSETTS

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During the summer of 1939 the Department of Public Health of the State of Massachusetts conducted a state-wide mosquito survey with the cooperation of the Works Projects Administration. This survey was one phase in the program of a study of the general problem of encephalitis. It was initiated following an outbreak of encephalitis in man in 1938 which was traced to the eastern virus of equine encephalomyelitis. The identification of biting mosquitoes was made by using a key compiled by Tulloch (1930) which was taken from Dyar (1922) and Matheson (1929) and modified to include those species reported from New England. The present key is a revision of the earlier one which has been enlarged to include the non-biting as well as the biting mosquitoes and is based on the examination of over 100,000 specimens. Although this key is restricted to the species which may be found in Massachusetts it is sufficiently inclusive for use in any of the New England states. It is accompanied by illustrations of many of the characters of taxonomic importance and by a summary of the species of Culicidæ which have been taken in Massachusetts.

[1] Grateful acknowledgment is made to the following for assistance: Dr. R. F. Feemster, Director, Division of Communicable Diseases, Massachusetts Department of Public Health; Dr. V. A. Getting, Technical Director, Massachusetts Mosquito Survey; Prof. J. C. Bequaert, Consulting Entomologist; V. A. Bell, R. P. Holdsworth, Jr., C. E. Elliott, Dr. B. W. Parker, Dr. J. W. Hawkins, G. C. Tower, H. D. Rose, and R. O. Bohm, Entomologists and to Mr. J. Milano for preparation of the plates.

The material for this key has been modified from the works of many authors, notably Smith (1903), Headlee (1921), Dyar (1922, 1928), Dyar and Shannon (1924), Matheson (1925, 1929), Bradley (1936), Edwards (1932), Johannsen (1903, 1923, 1934), Marshall (1938) and King, Bradley and McNeel (1939).

Mosquitoes are small two-winged insects belonging to the order Diptera, family Culicidæ. The Culicidæ are separated from all other Diptera by a characteristic wing venation which is outlined by Edwards (1932) as follows: Subcosta (Sc) long and reaching costa; radius 4-branched, R_{2+3} forked, R_{4+5} simple, no cross vein connecting R_1 and R_2; media two branched; cross veins r-m and m-cu both present; cubitus forked; anal vein long and reaching wing margin; axillary vein absent or very faint (Fig. 5). There is no other single character which separates the family from other Diptera. Other common family characters are (1) the small or rudimentary first antennal segment and the more or less enlarged second segment, (2) the completely divided pronotum, the posterior divisions of which appear to form part of the pleuræ. These characters, however, are not distinctive since they are shared by one or more families of Diptera.

The larvæ of the Culicidæ are distinguished from all other dipterous larvæ by the presence of a complete head capsule and of only one pair of functional spiracles situated dorsally on the eighth abdominal segment opening free to the surface (Fig. 19) or into an air tube or by the presence of a complete head capsule and air sacs in the thorax and seventh abdominal segment (Fig. 17) (*Chaoborus*).

KEY TO SUBFAMILIES OF CULICIDAE

Adults

1. Antennal flagellum 14 segmented; vein Sc ending above or before base of Rs (Fig. 5). Mouthparts short, wings without scales: ..... *Dixinæ*
   Antennal flagellum 13 segmented; vein Sc ending much beyond base of Rs. Wings with scales at least on fringe 2
2. Mouthparts short, palpi incurved; scales almost confined to wing fringe: ..... *Chaoborinæ*
   Mouthparts modified to form a long proboscis, palpi not incurved; wing veins and legs scaly: ..... *Culicinæ*

Larvæ

1. Thorax narrow with distinct segmentation; prolegs on the first 2 abdominal segments; tracheæ ending in a pair of discs on eighth abdominal segment (Fig. 21): ..... *Dixinæ*
   Thorax distinctly broader than abdomen, without distinct segmentation, paired prolegs lacking 2
2. Antennæ prehensile, with long and strong apical spines (Fig. 17): ..... *Chaoborinæ*
   Antennæ not prehensile (Fig. 8): ..... *Culicinæ*

Subfamily Dixinæ

This group is represented by the single genus *Dixa*.

KEY TO THE GENUS DIXA

Adults

1. Tips of hind tibiæ noticeably enlarged, deep black, sharply contrasting with the remainder of the member; wing veins with clouded margins; proboscis black, halteres yellowish, scutellum fuscous testaceous; terminal clasper segment tapering, mesal process of the basal segment simple, elongate: ..... *clavata*
   Tips of hind tibiæ not so sharply differentiated 2
2. Petiole of R_{2+3} (measured on a straight line from its base to base of fork) less than 3/8 as long as R_3; proboscis, scutellum, and knob of the halteres yellow; crossvein of wing very feebly clouded, r-m crossvein slightly distad of the base of R_{4+5}: ..... *terna*
   Wing with other characters 3
3. Wing with one distinct spot 4
   Wing spot very indistinct or wanting 5
4. Petiole of R_{2+3} and R_3 subequal in length; proboscis and scutellum blackish: ..... *centralis*
   Petiole shorter; proboscis and scutellum yellowish: ..... *notata*
5. Dorsum of the thorax as well as the upper part of the pleura black; proboscis, halteres and scutellum dark: ..... *fusca*
   Dorsum of the thorax yellowish with thoracic darker

stripes which may be more or less confluent; palpi dark 6

6. First tarsal joint of fore leg about ⅔ as long as the tibia: ..... *cornuta*

   First tarsal joint of fore leg about ¾ as long as the tibia 7

7. Apical segment of the clasper of the male fully as broad beyond the middle as at the base; Sc ends about opposite the base of Rs; distance between the crossveins measured on the media usually not exceeding ½ the length of the m-cu crossvein: ..... *modesta*

   Apical segment of the clasper of the male tapering; Sc ends distinctly proximad of the base of Rs; distance between the crossveins about equal to the length of the m-cu crossvein: ..... *similis*

Larvæ

Only two of the species given in the key above are known in the larval stage, *D. modesta* Joh. and *D. cornuta* (Joh:) which may be separated by using the key by Johannsen (1934).

Subfamily Chaoborinæ

KEY TO GENERA

Adults

1. Clypeus small and nearly bare; R_1 ending far from tip of R_2: ..... *Corethrella*

   Clypeus larger and very hairy; R_1 ending close to tip of R_2 2

2. First tarsal segment much shorter than second: ..... *Mochlonyx*

   First tarsal segment longer than second 3

3. Clypeus as long as head; claws larger and toothed: ..... *Eucorethra*

   Clypeus shorter than head; claws small and simple: ..... *Chaoborus*

Larvæ

1. Eighth abdominal segment with an elongate single dorsal respiratory siphon or air tube 2

Eighth abdominal segment without an elongate single dorsal air tube; with a flattened spiracular disc on the eighth segment or with air sacs in the thorax and the seventh abdominal segment 3

2. Antennæ inserted close together, folding outwardly and fitting into grooves on the head (Fig. 20) : ..... *Corethrella*

Antennæ inserted far apart, pendent in resting position (Fig 18) : ..... *Mochlonyx*

3. Air sacs present in thorax and seventh abdominal segment (Fig. 17) : ..... *Chaoborus*

Air sacs absent, a well-developed spiracular disc on eighth abdominal segment (Fig. 19) : ..... *Eucorethra*

KEY TO THE GENUS CHAOBORUS

Adults

1. Wings spotted or clouded 2

Wings without spots or clouds 4

2. Width of hind marginal wing fringe nearly as great as distance between cubitus and hind margin 3

Hind marginal wing fringe less than half the distance between cubitus and hind margin: ..... *trivittatus*

3. Femora and tibiæ with numerous distinct spots: ..... *punctipennis*

Femora and tibiæ without distinct spots except at bases and apices: ..... *albatus*

4. Mesonotum with dark longitudinal bands: *americanus*

Mesonotum with yellowish red longitudinal bands: ..... *albipes*

*Larvæ**

1. Pre-labral leaf-like appendages very narrow and lanceolate: ..... *punctipennis*

Pre-labral leaf-like appendages less than seven times as long as broad 2

2. Mandibular fan with 25 or more rays: ..... *americanus*

Mandibular fan with not over 18 rays 3

3. Mandibular fan with 16-18 rays: ..... *trivittatus*

Mandibular fan with not more than 12 rays: ..... *albipes*

Larva of *C. albatus* is unknown.

KEY TO THE GENUS MOCHLONYX

Adults

1. Wing vestiture entirely pale yellow 2
   Wing vestiture black and yellow: ..... *cinctipes*
2. Scutellar setæ numerous, arranged in two or three irregular rows: ..... *karnerensis*
   Scutellar setæ sparse, arranged in a single row: ..... *fuliginosus*

*Larvæ**

1. Clypeal and frontal spines barbed from base to a little beyond middle: ..... *karnerensis*
   These spines with long barbs beyond middle: ..... *cinctipes*

* The larva of *M. fuliginosus* is unknown.

The following genera of the Chaoborinæ are represented by single species: *Corethrella brakeleyi* Coquillett and *Eucorethra underwoodi* Underwood.

Subfamily Culicinæ

KEY TO GENERA

Adults

1. Postnotum with a median tuft of setæ located near the posterior margin (Fig. 2): ..... *Wyeomyia*
   Postnotum without a tuft of setæ 2
2. Wings with the second marginal cell not half as long as its petiole (Fig. 5): ..... *Uranotænia*
   Wings with the second marginal cell more than half as long as its petiole 3
3. Scutellum rounded or crescent-shaped with an even fringe of marginal setæ (Fig. 3): ..... *Anopheles*
   Scutellum distinctly trilobed (Fig. 4) with marginal setæ aggregated on the lobes 4
4. Spiracular bristles present (Fig. 2) 5
   Spiracular bristles absent 6
5. Post-spiracular bristles present (Fig. 2); abdomen of female with the eighth segment wholly retractile: ..... *Psorophora*
   Post-spiracular bristles absent; cross veins of wings

tending to lie in line, or mesonotum with bare areas devoid of scales or both: ..... *Theobaldia*

6. Pronotal bristles only two stout setæ (Fig. 2); proboscis with black and white scales so arranged as to form longitudinal striæ; mesonotum with six longitudinal lines of white scales: ..... *Orthopodomyia*

   Pronotal bristles more than two, generally a prominent row; proboscis without longitudinal striæ; mesonotum without six longitudinal lines of white scales 7

7. Wings with scales distinctly large and broad; first joint of all tarsi with broad median rings; all of the other tarsal joints black with basal half white scaled: ..... *Mansonia*

   Wings with scales normal; tarsi not as above 8

8. Post-spiracular bristles present; female usually with the abdomen pointed and the cerci exserted or tarsi with white rings on both ends of joints: ..... *Aedes*

   Post-spiracular bristles absent; female with a blunt abdomen; tarsi without white rings involving both ends of joints: ..... *Culex*

Larvæ

1. Eighth segment of abdomen provided with a distinct, elongate respiratory or air tube (Fig. 8) 2

   Eighth segment of abdomen without a distinct, elongate respiratory or air tube (Fig. 9): ..... *Anopheles*

2. Air tube without a pecten (Fig. 12) 3

   Air tube with a pecten (Fig. 8) 5

3. Air tube about twice as long as wide, the apical portion sharply attenuated and provided with saw-like teeth dorsally for penetrating into plant tissues (Fig. 12); larva found attached to the roots of certain aquatic plants: ..... *Mansonia*

   Air tube about three times as long as wide, tapering more or less uniformly to the apex 4

4. Air tube with many short single hairs; larva found in the water of the pitcher plant: ..... *Wyeomyia*

   Air tube without scattered single hairs but with a large pair of hair tufts before the middle; abdomen

with dorsal chitinous plates on the sixth, seventh and eighth segments: ..... *Orthopodomyia*

5. Head elongate, elliptical; head hairs single, stout like heavy spines: ..... *Uranotænia*
   Head nearly circular or transverse; head hairs not like heavy spines 6
6. Air tube with several pairs of ventral tufts: ..... *Culex*
   Air tube with a single pair of ventral tufts or with a single pair of tufts and a median ventral row of 10 to 12 unpaired tufts or without any paired ventral tufts 7
7. Air tube with the paired hair tufts placed close to the base between the pecten rows: ..... *Theobaldia*
   Air tube with the paired hair tufts placed near or beyond the middle 8
8. Anal segment ringed by the dorsal plate, with tufts of the ventral brush piercing the ring: ..... *Psorophora*
   Anal segment not ringed by the dorsal plate, or if ringed, the tufts of the ventral brush posterior to the ring: ..... *Aedes*

KEY TO THE GENUS AEDES

Adults

1. Proboscis of female ringed with white (Fig. 1) 2
   Proboscis of female not ringed with white 3
2. Abdomen with a pale longitudinal dorsal stripe (Fig. 1); wings with black and white scales: ..... *sollicitans*
   Abdomen without a pale longitudinal dorsal stripe; wings with black scales: ..... *tæniorhynchus*
3. Tarsi with white rings on at least some of the segments (Fig. 1) 4
   Tarsi without white rings 11
4. White tarsal rings involving both ends of segments 5
   White tarsal rings basal only 7
5. Wings scales markedly bicolored: ..... *dorsalis*
   Wings scales uniformly dark, or nearly so 6
6. Mesonotum uniformly reddish brown, or nearly so: ..... *canadensis*
   Mesonotum pale with a broad dark medium stripe; abdomen rather bluntly rounded: ..... *atropalpus*

7. Tarsi with pale broad rings especially on hind legs; wings scales bicolored 8
   Tarsi with narrow rings; wing scales uniformly dark or nearly so 10
8. Lower mesepimeral bristles absent: ..... *excrucians*
   Lower mesepimeral bristles present (Fig. 2) 9
9. With three to five lower mesepimeral bristles; mesonotum bronzy-brown on the disc, the scales on the antescutellar space, lateral margins and a sub-dorsal line each side of the disc whitish: ..... *stimulans*
   With two lower mesepimeral bristles; mesonotum with a broad median stripe of yellowish brown scales, the anterior edge, the sides of the disc and antescutellar space with yellowish white to white scales: ..... *fitchii*
10. Last two abdominal segments nearly entirely white scaled, venter entirely yellowish white: ..... *cantator*
    Last two abdominal segments with apical and basal bands; venter with each segment with a median black spot or stripe which may be joined to lateral black spots forming a Y: ..... *vexans*
11. Lower mesepimeral bristles absent 12
    Lower mesepimeral bristles present 17
12. Mesonotum with silvery scales 13
    Mesonotum without silvery scales 15
13. Mesonotum silvery on the sides with a dark brown median stripe which widens behind the middle and which is divided by the antescutellar space, the antescutellar space is margined by silvery scales: ..... *triseriatus*
    Mesonotum with a medium silvery stripe reaching scutellum or entirely silvered 14
14. Mesonotum with a broad well-defined median silvery stripe: ..... *atlanticus*
    Mesonotum with a narrower poorly defined or diffuse median stripe; mesonotum of male entirely silvery; a very small blackish species: ..... *dupreei*
15. Abdomen with a continuous lateral white line; mesonotum uniformly colored with golden-brown scales, paler about the antescutellar space: ..... *cinereus*
    Abdomen without a continuous lateral white line; me-

sonotum with a median dark band 16

16. Mesonotum with two yellow or yellowish-white stripes separated by a narrow, dark brown median band; sides dark brown to black: ..... *trivittatus*

Mesonotum with the golden brown median stripe slightly constricted at the middle; with two short sublateral stripes posteriorly: ..... *hirsuteron*

Mesonotum with the median band widening posteriorly; apical margins of abdominal segments with fine long brownish hairs: ..... *aurifer*

17. With one to three small mesepimeral bristles; mesonotum with brownish-yellow scales uniformly distributed: ..... *intrudens*

With three or more stout mesepimeral bristles; mesonotum with a median stripe or paired brown median lines 18

18. Mesonotum with paired brown median lines 19

Mesonotum with a median brown stripe 20

19. Mesonotum yellow or bronzy with a pair of black median lines, often joined into a median stripe; legs deep black: ..... *diantæus*

Mesonotum with paired median lines separated by a broad golden brown line: ..... *impiger*

Mesonotum with paired median lines separated by a narrow yellow line; sides grayish: ..... *communis*

20. Mesonotum with the median band laterally expanded near the middle: ..... *trichurus*

Mesonotum with the median band only slightly darker than the lateral margins: ..... *punctor**

..... *implacabilis**

*There are no satisfactory characters with which to separate these species. In *A. punctor* the median band of the mesonotum may in some cases have a middle line of slightly paler scales. The last abdominal segment of *A. implacabilis* is usually pale scaled whereas in *punctor* it has a V-shaped dark area.

Larvæ

1. Air tube with tuft within pecten 2

Air tube with tuft beyond pecten 3

2. Air tube with several dorsal hair tufts, anal gills normal: ..... *trichurus*
   Air tube without several dorsal hair tufts, anal gills large and inflated: ..... *atropalpus*
3. Pecten with detached teeth outwardly (Fig. 15) 4
   Pecten without detached teeth outwardly (Fig. 16) 9
4. Antennæ enlarged basally: ..... *aurifer*
   Antennæ not enlarged basally 5
5. Antennæ as long as head: ..... *diantæus*
   Antennæ not as long as head 6
6. Both pairs of head hairs (Fig. 8) double: ..... *excrucians*
   Both pairs of head hairs not double 7
7. Lateral abdominal hairs (Fig. 8) single beyond second segment 8
   Lateral abdominal hairs not single beyond second segment: ..... *vexans*
8. Air tube 2½ to 3 times as long as wide, tuft on air tube large: ..... *intrudens*
   Air tube 3½ to 4 times as long as wide, tuft on air tube small, located on outer third of tube: ..... *cinereus*
9. Comb scales in a single or in an irregular single row 10
   Comb scales in a triangle 13
10. Anal segment ringed by plate 11
    Anal segment not ringed by plate: ..... *triseriatus*
11. Air tube five times as long as wide: ..... *dupreei*
    Air tube 2 to 3½ times as long as wide 12
12. Dorsal brush of anal segment consisting of two pairs of long hairs: ..... *implacabilis*
    Dorsal brush of anal segment consisting of a pair of long hairs and a pair of dorsal tufts: ..... *atlanticus*
13. Anal segment ringed by plate 14
    Anal segment not ringed by plate 17
14. Upper and lower head hairs double: ..... *punctor*
    Upper and lower head hairs single 15
15. Anal gills at least as long as anal segment: ..... *trivittatus*
    Anal gills shorter than anal segment 16
16. Lateral abdominal hairs double on segments two to five; scale of comb with a stout apical spine: ..... *sollicitans*

Lateral abdominal hairs triple on segments three to five; scale of comb with a fringe of spines of approximately equal length: ..... *tæniorhynchus*

17. Air tube at least four times as long as wide: ..... *fitchii*
    Air tube three times or less as long as wide 18
18. Head hairs single 19
    Head hairs double or multiple 21
19. Anal gills at least as long as anal segment 20
    Anal gills much shorter than anal segment: ..... *dorsalis*
20. Scale of comb with broad apex bearing four to seven stout spines: ..... *communis*
    Scale of comb with single stout spine: ..... *impiger*
21. Both pairs of dorsal head hairs multiple 22
    Both pairs of dorsal head hairs not multiple 23
22. Anal gills budlike; found in salt water: ..... *cantator*
    Anal gills well developed: ..... *canadensis*
23. Lower head hairs double, upper triple: ..... *hirsuteron*
    Lower head hairs single, upper double: ..... *stimulans*

KEY TO THE GENUS THEOBALDIA

Adults

1. Tarsi with poorly defined yellowish white rings at both ends of some of the joints: ..... *morsitans*
   Tarsi without rings on any of the joints 2
2. Scales of the wings mixed, black or brown and white especially along the costal margin; proboscis with intermixed black and white scales: ..... *inornata*
   Scales of the wings all brown or black 3
3. Mesonotum brown marked with yellowish lines or spots; wings with some of the scales slightly aggregated along the third vein; a large species: ..... *impatiens*
   Mesonotum entirely reddish brown; wing scales normal; each abdominal segment with an apical row of coarse yellow hairs; a small species (4 mm.): ..... *melanura*

Larvæ

1. Pecten produced into long hairs on outer half (Fig. 13) 2
   Pecten not produced into long hairs on outer half 3

2. Both pairs of head hairs consisting of tufts having approximately six hairs, all of about equal length: ..... *impatiens*
   Lower head hairs of three or four long hairs, upper head hairs multiple and shorter than the lower hairs: ..... *inornata*
3. Comb scales in a single row; air tube with a row of 10-12 median unpaired tufts along the ventral side beyond the pecten: ..... *melanura*
   Comb scales in a triangle; air tube without unpaired median ventral tufts beyond the pecten: ..... *morsitans*

KEY TO THE GENUS PSOROPHORA

Adults

1. Mesonotum brown with a median longitudinal stripe of brilliant golden curved scales bordered by narrow bare stripes ..... *ciliata*
   Mesonotum uniformly colored 2
2. Claws of the female toothed (Fig. 6); wing scales dark: ..... *posticata*
   Claws of the female not toothed (Fig. 7); wings uniformly marked with black and white scales: *columbiæ*

Larvæ

1. Both pairs of head hairs single, upper pair very short: ..... *ciliata*
   Both pairs of head hairs not single 2
2. Upper and lower pairs of head hairs multiple; pecten of three to five teeth widely separated on the basal half of the tube (Fig. 14): ..... *columbiæ*
   Upper and lower pairs of head hairs double; pecten of three to four teeth on the basal fifth of tube; tuft of air tube absent: ..... *posticata*

KEY TO THE GENUS ANOPHELES

Adults

1. Palpus with white markings 2
   Palpus without white markings 3
2. Apical segment of palpus entirely white scaled; anal vein with three dark spots separated by white (two spots in the male): ..... *crucians*

Apical segment of the palpus white-tipped; anal vein entirely dark without spots: ..... *walkeri*

3. Costal margin of wing with two white or yellowish-white spots, a large one beyond the middle and a small one at the apical end: ..... *punctipennis*
   Costal margin of wing without white or yellowish-white spots 4
4. Fringe at apex of wing with a distinct light yellow to coppery spot: ..... *maculipennis*
   Fringe at apex of wing without a distinct light yellow to coppery spot 5
5. Wing with dark scales uniformly distributed: ... *barberi*
   Wing with the dark scales definitely aggregated to form dark spots at the base of the radical sector, at cross-veins r-m and m-cu, at fork of R_2 and R_3 and at fork of M_{1+2} and M_{3+4} : ..... *quadrimaculatus*

Larvæ

1. Abdomen with plumose lateral hairs (Fig. 9) on first six segments; head hairs simple: ..... *barberi*
   Abdomen with plumose lateral hairs on first three segments; head hairs plumose 2
2. Abdominal segments 4 and 5 with two conspicuous tufted hairs (Fig. 11) (hair 0 and the antepalmate or hair 2) anterior to the palmate tuft, these hairs usually approximately equal in size and with four to nine branches; fresh water form: ..... *crucians*
   Abdominal segments 4 and 5 with but one conspicuous hair (antepalmate or hair 2) anterior to the palmate tuft, this hair may be single or with two or three branches 3
3. Abdomen with the palmate tufts on segments 3 to 7 inclusive, of similar form but those on segments 3 and 7 distinctly smaller than the others; posterior clypeal hairs (Fig. 10) long and usually single; tubercles of inner anterior clypeal hairs (Fig. 10) wide or close; brackish water form: ..... *crucians*
   Abdomen with the palmate tufts on segment 3 approximately equal in size to those on the succeeding segments 4

4. Tubercles of inner anterior clypeal hairs separated by at least the width of one of these tubercles; antepalmate hairs on segments 4 and 5 usually single; palmate tufts on segment 2 usually well developed: ..... *quadrimaculatus*

   Tubercles of inner anterior clypeal hairs so close together that another tubercle of similar size could not be placed between them 5

5. Inner anterior clypeal hairs not minutely feathered toward tip; antepalmate hairs of abdominal segments 4 and 5 usually double or multiple 6

   Inner anterior clypeal hairs minutely feathered toward tip; antepalmate hairs of abdominal segments 4 and 5 usually single: ..... *walkeri*

6. Antepalmate hairs of abdominal segments 4 and 5 usually with 2 branches, rarely 1 or 3; posterior clypeal hairs usually with 2 branches from near base; inner anterior clypeal hairs single, unbranched: ..... *punctipennis*

   Antepalmate hairs of abdominal segments 4 and 5 usually with 3 branches, rarely with 2 or 4; posterior clypeal hairs usually long with apical branching; inner anterior clypeal hairs unbranched or with 2 or 3 branches beyond middle: ..... *maculipennis*

KEY TO THE GENUS CULEX

Adults

1. Abdominal segments with transverse apical white bands: ..... *apicalis*

   Abdominal segments with basal white bands or none: 2

2. Abdominal segments with basal white bands 3

   Abdominal segments without basal white bands: ..... *salinarius*

3. Basal white band of the second abdominal segment triangularly produced medianly: ..... *pipiens*

   Basal white band of the second abdominal segment transverse: ..... *territans*

Larvæ

1. Antenna with the tuft at or before the middle ..... *territans*

   Antenna with the tuft beyond the middle 2

2. Both upper and lower head hairs multiple 3
   Both upper and lower head hairs not multiple, usually single but with all variations between the complete single and complete double condition, rarely with one or two head hairs triple: ..... *apicalis*
3. Air tube long and slender, about seven times as long as broad, slightly expanded before the apex; subdorsal hairs on segments three to six multiple: .. *salinarius*
   Air tube not over five times as long as wide tapering uniformly toward the apex; subdorsal hairs double on segments three to six: ..... *pipiens*

The following genera of Culicinæ are represented by single species; *Mansonia perturbans* (Walker), *Orthopodomyia signifera* (Coquillett), *Uranotænia sapphirina* (Osten Sacken), *Wyeomyia smithii* (Coquillett).

Summary of Species of Culicidae Reported from Massachusetts

The following species of mosquitoes were reported by Johnson (1925):

Subfamily Dixinæ

Dixa centralis Loew
D. clavata Loew
D. cornuta Johannsen
D. modesta Johannsen
D. notata Loew

Subfamily Chaoborinæ

Mochlonynx cinctipes Coquillett as *Corethra cinctipes* Coquillett
M. karnerensis Felt as *Corethra culiciformis* (DeGeer)
M. fuliginosus Felt as *Corethra fuliginosus* Felt.
Chaoborus albipes (Johannsen)
C. americanus Johannsen as *C. crystallina* DeGeer
C. albatus Johnson
C. punctipennis Say
C. trivittatus Loew

Subfamily Culicinæ

Wyeomyia smithii (Coquillett)

Erratum

page 129, first line, above *Culex apicalis* insert:
Culex pipiens Linnæus

Culex apicalis Adams as *C. testaceus* Van der Wulp
C. territans Walker
C. salinarius Coquillett
Theobaldia melanura (Coquillett) as *Culex melanurus* (Coquillett)
T. morsitans (Theobald) as *Culiseta dyari* (Coquillett)
T. inornata (Williston) as *Culiseta inornatus* (Williston)
Mansonia perturbans (Walker) as *Taeniorhynchus perturbans* (Walker)
Psorophora ciliata (Fabricius)
P. posticata (Wiedemann) as *P. sayi* Dyar and Knab
Aedes trivittatus (Coquillett)
A. aurifer (Coquillett)
A. punctor (Kirby)
A. intrudens Dyar
A. hirsuteron (Theobald)
A. communis (DeGeer) as *A. lazarensis* (Felt and Young)
A. dorsalis (Meigen)
A. canadensis (Theobald)
A. stimulans (Walker)
A. cantator (Coquillett)
A. fitchii (Felt and Young)
A. trichurus (Dyar) as *A. cineroborealis* Felt and Young
A. atropalpus (Coquillett)
A. excrucians (Walker)
A. taeniorhynchus (Wiedemann)
A. sollicitans (Walker)
A. triseriatus (Say)
A. vexans (Meigen)
A. cinereus (Meigen)
A. impiger (Walker)
Uranotænia sapphirina (Osten Sacken)
Anopheles punctipennis (Say)
A. quadrimaculatus (Say)
A. maculipennis (Meigen)
A. walkeri (Theobald)

In 1930 one additional Culicine was reported by Tulloch:

Aedes implacabilis (Walker) or *Aedes abserratus* (Felt and Young)

Several species new to Massachusetts have been recovered during the present survey. They are as follows:

Subfamily Chaoborinæ

Eucorethra underwoodi Underwood—Yarmouth, July 27, 1939, Armstrong

Corethrella brakeleyi Coquillett—Taunton, July 20, 1939, Collector M. W. Chambers

Subfamily Culicinæ

Psorophora columbiæ Dyar and Knab—Northampton, July 18, 1939, Collector W. J. Neunier

Orthopodomyia signifera (Coquillett)—Sudbury, August 28, 1939, Collector W. J. Normandin

Anopheles crucians Wiedemann—Orleans, August 29, 1939, Collector J. L. Drew

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Explanation of Plates

Plate 4

1. Female mosquito (after John B. Smith).

Plate 5

2. Side view of thorax showing bristle areas.
3. Dorsal view of crescent-shaped scutellum.
4. Dorsal view of trilobed scutellum.
5. Generalized wing of a mosquito.
6. Tarsus with toothed claws.
7. Tarsus with simple claws.

Plate 6

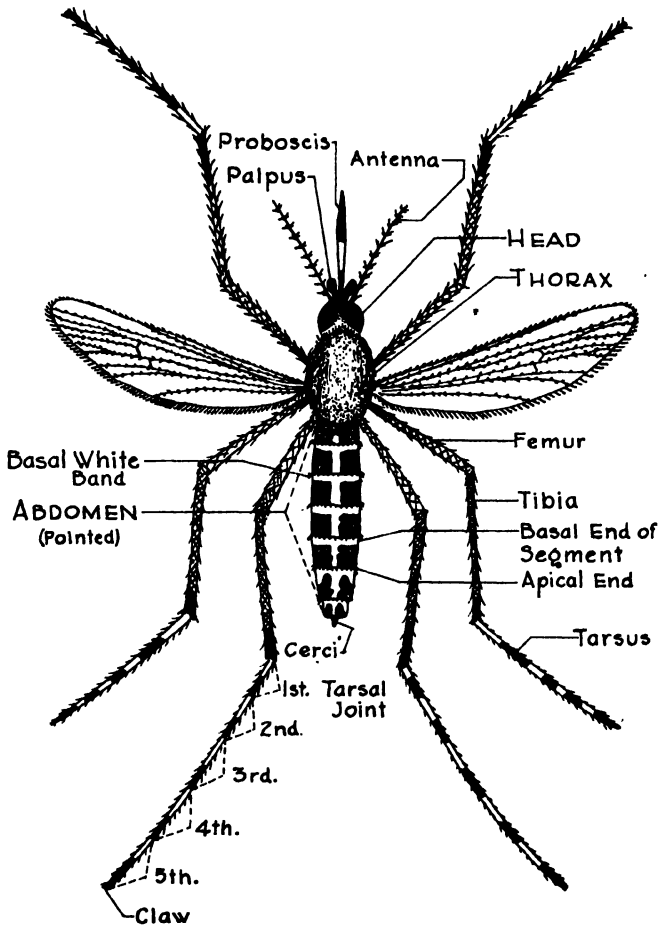
8. Larva of *Aedes* (after Marshall).
9. Larva of *Anopheles* (after Marshall).

Plate 7

10. Head of *Anopheles* larva (after Marshall).
11. Dorsal view of segments 4 and 5 of *Anopheles* larva.
12. Air tube sharply attenuated without a pecten.
13. Air tube with some of the pecten teeth produced into long hairs.
14. Air tube fusiform with small tuft (after Dyar).
15. Air tube with pecten teeth detached outwardly.
16. Air tube with pecten teeth not detached outwardly.

Plate 8

17. Larva of *Chaoborus* (after Johannsen).
18. Larva of *Mochlonyx* (after Johannsen).
19. Larva of *Eucorethra* (after Johannsen).
20. Larva of *Corethrella* (after Johannsen).
21. Larva of *Dixa* (after Johannsen).



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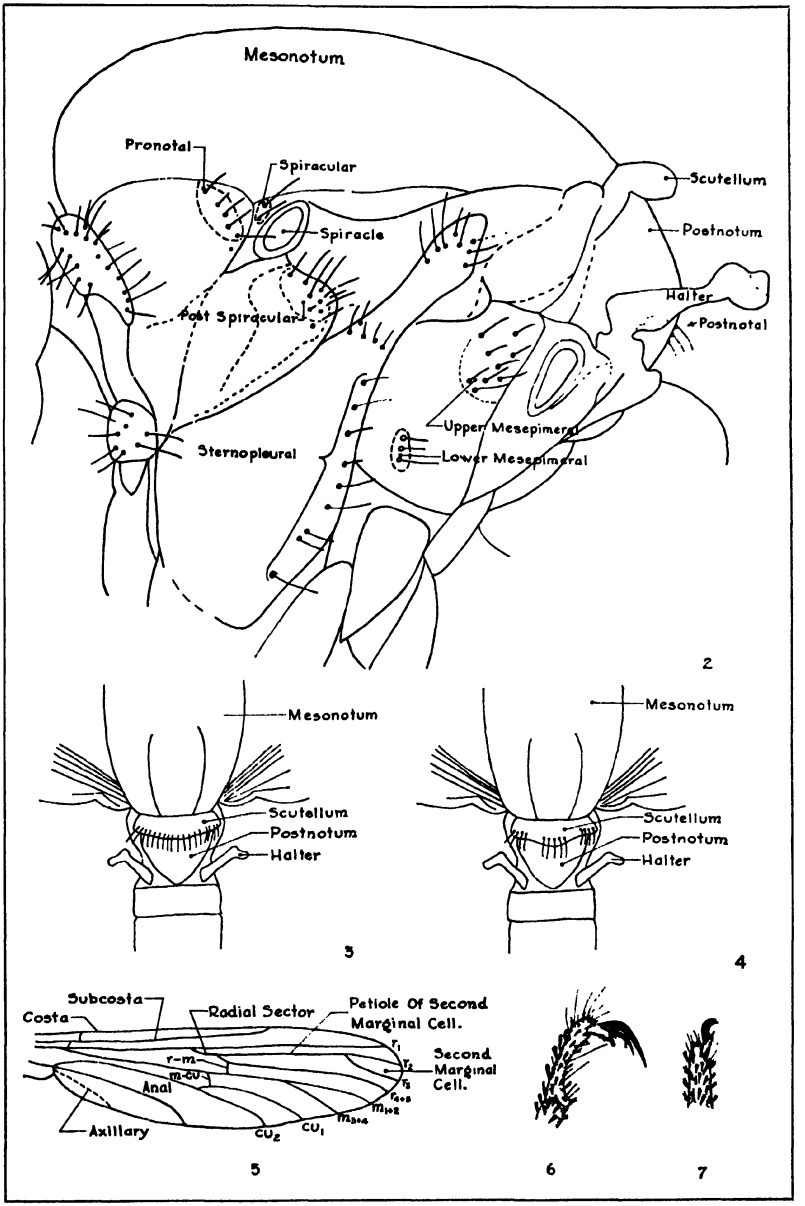
Tulloch — Mosquitoes of Massachusetts.



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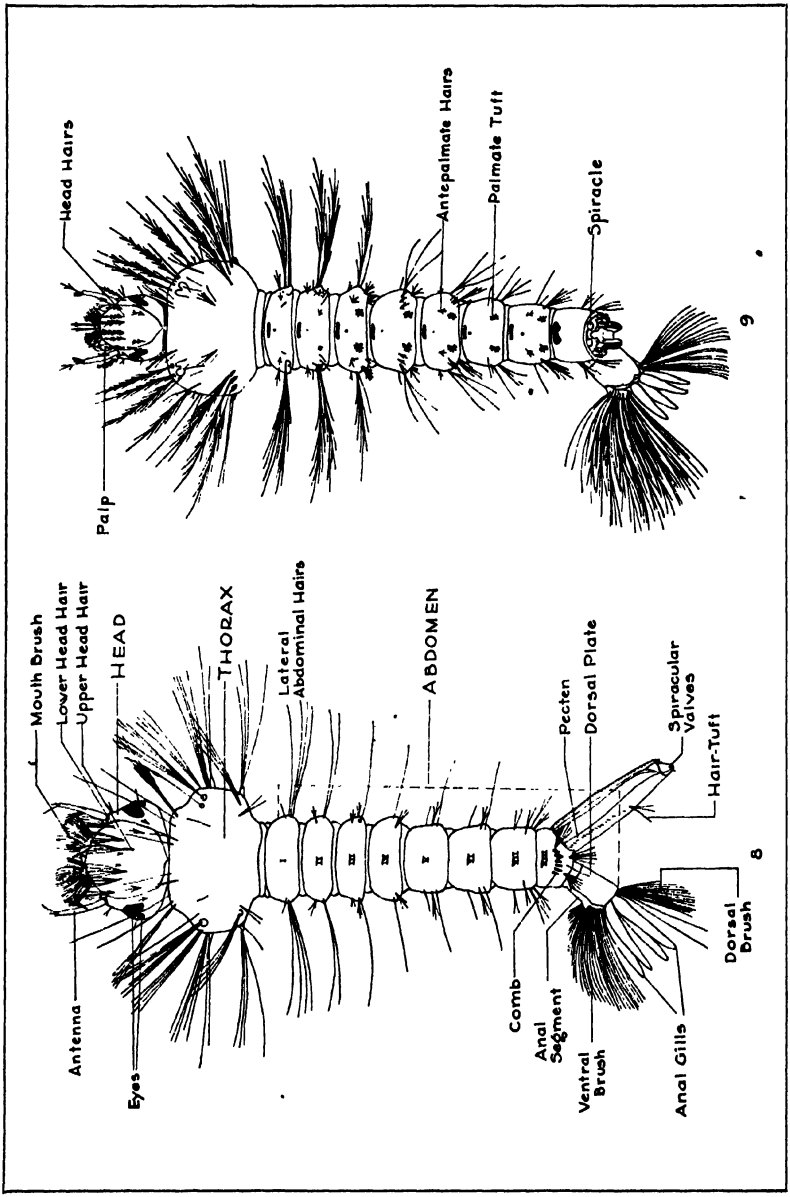

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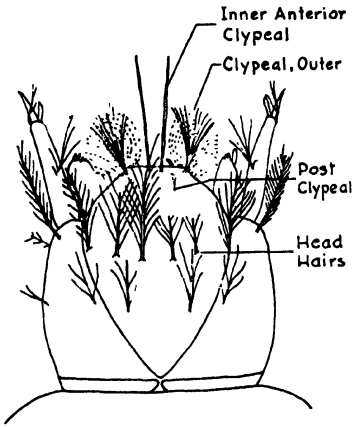
Psyche, 1939 Vol. 46, Plate VII.



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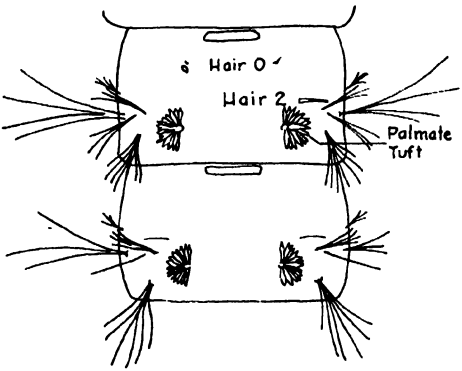

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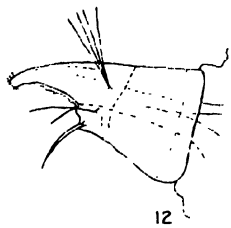

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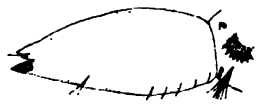

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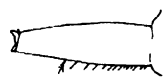

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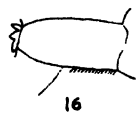

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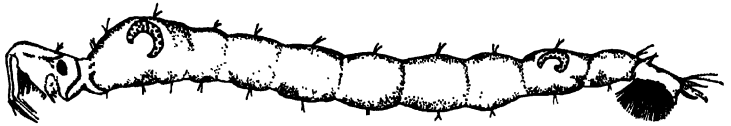

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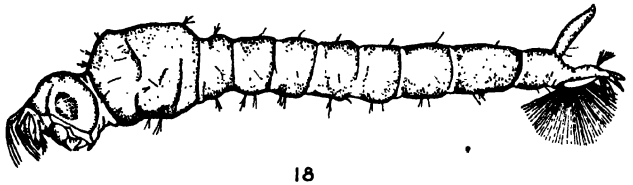

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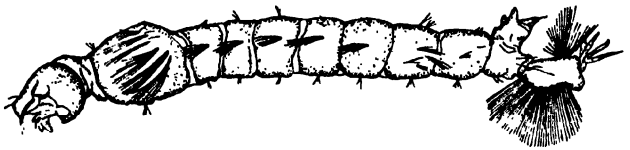

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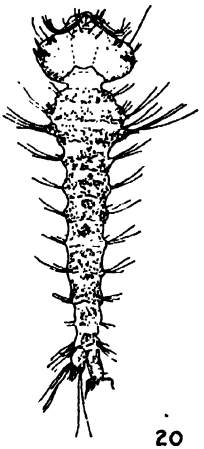

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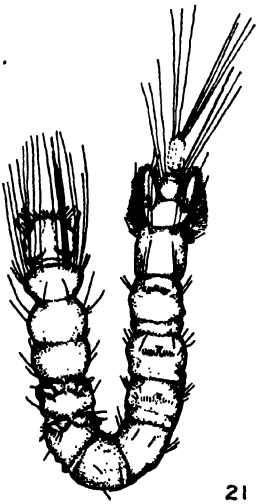

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Tulloch — Mosquitoes of Massachusetts.

A NEW SUBSPECIES OF *CREMATOGASTER MINUTISSIMA* WITH REVISIONARY NOTES CONCERNING THAT SPECIES. (HYMENOPTERA:FORMICIDÆ)

By William S. Creighton

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In 1895 Carlo Emery published the second half of his monograph dealing with North American ants. A considerable proportion of the material on which this work was based had come to Emery from Pergande who was, at that time, connected with the National Museum. As a general rule Pergande gave no names to the ants which he sent to his colleague probably because, in most cases, he was not sure as to what was new. In the instance which I wish to discuss here, however, Pergande had not only recognized the form as new but had selected the name which it now bears. There seems to be no other interpretation which can be placed upon Emery's treatment of *Crematogaster victima* subsp. *missouriensis*. Emery attributed this form to Pergande, stating that the latter had used the name *in litteris*. There is no method whereby one can determine whether Pergande was actually preparing to publish a description of *missouriensis* and it makes very little difference if he was. Emery accompanied his citation of the form with a brief characterization permitting its recognition. This, of course, is the original description of *missouriensis*, which is to be attributed to Emery and not Pergande. I do not doubt that many would regard this as a flagrant case of name-grabbing but it is by no means certain that such was the case. It is difficult to believe that Emery supposed that he could give *missouriensis* to Pergande by merely citing him as author. It seems more probable that Emery was under the impression that Pergande would publish the description of the new form before the appearance of his (Emery's) monograph and that he inad-

vertently let slip into print a manuscript notation which was to have been subsequently altered. It is easier to be tolerant of this mistake than it is to agree with Emery's treatment of the taxonomic status of *missouriensis*. I can see no reason why he should have assigned it to *victima* instead of to Mayr's *minutissima*. In 1870 Mayr had published a key to the New World species of *Crematogaster* in which he clearly distinguished between the characteristics of Smith's *victima* and his own *minutissima*. Emery must surely have employed Mayr's key and just as surely he should have been aware that *missouriensis* is more closely related to *minutissima* than to *victima*. The distinct areas of cephalic punctures which are present in *victima* are absent in the other two forms. In recent years the recognition of a number of additional subspecies has considerably expanded the specific limits of *victima*. Even so the above contention can be defended. Still more peculiar is Emery's disregard for zoögeographical considerations. When he assigned *missouriensis* to *victima* the latter species was known only from Brazil. It would certainly have seemed more logical to consider the possibility of relationship with a species which had been found in the Gulf Coast region. As far as I can determine no one has ever questioned Emery's judgment in the matter. Despite this I believe that *missouriensis* should be regarded as a northern race of *minutissima*. In addition there is a western race which is described below.

Crematogaster (Orthocrema) minutissima thoracica subsp. nov.

The subspecies *thoracica* differs from the typical form and the subspecies *missouriensis* in its distinctly more shining thoracic dorsum. In both the other two forms the dorsum of the promesonotum bears, in addition to longitudinal rugæ, a number of fine and fairly close-set punctures. These punctures, while not dense enough to produce an opaque appearance, dull the surface to a considerable extent. They are not present in the subspecies *thoracica*. In addition *thoracica* usually lacks longitudinal rugæ on the pronotum and, when they are present, they appear to form a wavy border at the extreme edge of the pronotum. The longi-

tudinal rugæ in the typical *minutissima* are well developed and at least two of them lie well in towards the center of the pronotum. In *missouriensis* the rugæ are variable in position but when they occur at the edge of the thorax, as frequently happens, they are more prominent than in *thoracica*. The shape of the petiole seen from above is usually quite characteristic in *thoracica*. The sides gently diverge behind so that the petiole is widest at the rear. The difference is not great but the wedge-like appearance is rather different from that of the other two subspecies, where the petiole is more quadrate with the sides subparallel and widest, if there is much difference in width, at the middle. The epinotal spines of *thoracica* are short like those of the typical form. In other respects *thoracica* is very similar to the typical *minutissima*.

Described from a series of workers taken by W. M. Mann in Miller Canyon, Huachuca Mountains, Arizona (elevation 6000 ft.). In addition to this type series I have seen other specimens also secured by Dr. Mann, in Ramsey Canyon (elevation 5800 ft.) in the Huachucas.

Holotype (worker) and a series of paratypes in the collection of the Museum of Comparative Zoölogy. Additional paratypes in the collection of the American Museum of Natural History and the collection of the writer.

The three subspecies of *minutissima* and our single remaining species in the subgenus *Orthocrema*, Cr. (*O.*) *arizonensis*, may be separated as follows:

1. Tip of the antennal scape in repose notably surpassing the occipital border; color yellow; the gaster clothed with abundant long hairs 2

   Tip of the antennal scape in repose failing to reach the occipital border; color piceous brown; the erect hairs of the gaster short and sparse: ..... *arizonensis*

2. Dorsum of the promesonotum very smooth and shining; rugæ, if present, feeble and confined to the edge of the pronotum: ..... *minutissima thoracica*

   Dorsum of the promesonotum finely punctate in addition to the longitudinal rugæ, the surface feebly shining; rugæ well-developed and often placed towards the center of the thorax 3

3. Epinotal spines about one-half as long as the distance which separates their bases and rather strongly directed upward; pronotum with the rugæ usually lateral in position: ..... *minutissima missouriensis*

Epinotal spines less than half as long as the distance which separates their bases and directed more backward than upward; pronotum with two prominent rugæ near the middle: ..... *minutissima minutissima*

THREE NEW NEOTROPICAL COPROPHAGOUS COLEOPTERA

By Renaud Paulian

Laboratoire d'Entomologie du Museum, Paris

The three new species described herein were sent me for study, together with a long series of unnamed coprophagous Coleoptera, mostly from the Neotropical region, by the Museum of Comparative Zoölogy of Harvard University. I am glad of this opportunity to thank Dr. P. J. Darlington, Jr., for the most interesting material he sent me and for his generosity in allowing me to keep paratypes of the new species.

Besides the new species, the material sent to me contained a long series of species of Canthidium. For the most part they were probably new, at least the species were neither in the Paris Museum, the British Museum, nor in my own collection. But it should be necessary, before describing new species of this genus, and of the closely allied Choeridium, to make a general revision of the species, as Harold's monographs are old and rather inadequate.

I take this opportunity to indicate that *Uroxys productus* Arrow, described from an old specimen without locality label, has been collected by Dufau (in coll. Fleutiaux) under stones at Trois Rivieres, Guadeloupe Is., West Indies. It appears to be rare and found only in unique specimens.

Canthon darlingtoni n. sp. (fig. 1, 2, 7)

Type: One specimen from Colombia: Santa Marta (P. J. Darlington). Museum of Comparative Zoölogy, no. 23,693.

Paratypes: A small series of specimens from the same locality in my collection and the Museum of Comparative Zoölogy.

Length: 4.75-5.5 mm., breadth: 3-3.5 mm.

Body convex, orbicular, very broad, shining but minutely shagreened above. Head brown-red; thorax pale testaceous

with a large median anterior dark red patch; this patch touches the anterior margin, which is slightly darkened, as are also the lateral margins and the small lateral foveæ; middle of base with a vaguely rectangular dark patch. Elytra pale testaceous, with a dark transverse patch along the base; this patch broader at the sides, the sutural interstriæ darkened, a broad transverse patch about the middle, and on each elytron a small dark apical patch. Antennal club piceous, trophi yellow; legs red, with the femora largely testaceous in the middle, tarsi only slightly paler than the tibiæ. Underside red, with a small testaceous patch at the sides of the abdominal segments, this patch much larger on the last segment; pygidium reddish at the base, yellow at the apex.

Head rather broad, part of the eyes visible from above small and narrow; sides of the clypeus slightly raised, the anterior part impressed between the two anterior teeth; vertex with a slight median impression; anterior clypeal teeth curving upwards, rather long, parallel, rounded at apex; sides of the clypeus only very feebly sinuate between these teeth and the clypeogenal suture, which is very slightly marked; genal sutures feeble; genæ rounded, their greatest breadth at the middle. Head without any puncturation.

Thorax transverse, anterior angles acute, sides straight between those angles and the median angles, which are rounded and protrude very slightly behind. Posterior half of the sides gently rounded to the hind angles which are very slightly protruding behind, the sides of the base being feebly emarginated just inside these angles. Lateral margin a little more marked at the anterior angles; anterior margin complete; base gently rounded, with only a very slight angular protuberance in the middle; no scutellar impression. Puncturation very feeble and sparse, slightly stronger behind.

Elytral margins nearly straight, strongly curved behind; elytra convex, depressed along their apical margin; interstriæ flat, regular, only very sparsely and very feebly punctured; striæ distinct, not deep, distinctly punctured; scutellar impression very deep; elytral striæ ending anteriorly in small, basal, longitudinal foveæ; external epipleural margin very sharp, epipleura broad.

Pygidium nearly smooth, very short and broad, not margined at the base. No prosternal carina; mesosternum very

short; metasternum with a broad, arcuate fovea, smooth. Anterior tibia broad, with three very sharp and long marginal teeth; median and posterior tibiæ slightly arcuate and strongly carinate. Tarsi long, equal to ¾ of the tibial length, compressed, metatarsus much shorter than the second joint. Hind femora slightly clavate, not margined.

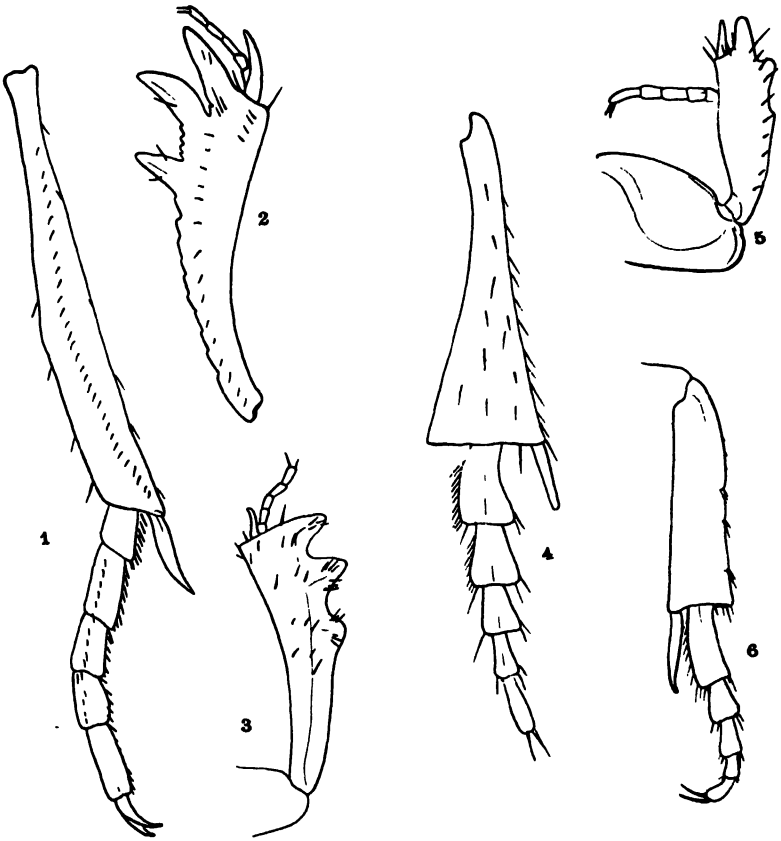

Fig. 1. *Canthon darlingtoni* n. sp., posterior leg.
Fig. 2. *id.*, anterior leg.
Fig. 3. *Uroxys pygmaeus*, anterior leg.
Fig. 4. *Bdelyrus bowditchi* n. sp., posterior leg.
Fig. 5. *Onthocharis panamensis* n. sp., anterior leg.
Fig. 6. *id.*, posterior leg.

This very pretty little species belongs to the group *cyanocephalus* Har. but it is quite peculiar by its colour pattern and its broad form.

Bdelyrus bowditchi n. sp. (fig. 3, 4)

Type: From British Honduras: M-tee district, F. C. Bowditch Collection. Museum of Comparative Zoölogy no. 23,694.

Paratype: One specimen from the same locality in my collection.

Length: 5 mm., breadth: 3.2 mm.

Body rather convex, with curved sides; very dark brown, not shining, all the upper surface finely but distinctly shagreened.

Head very broad and short; part of the eyes visible from above very large, nearly round; clypeus impressed in front, with four teeth, the median teeth very close together, long, broad, upturned and rounded at tip; lateral teeth very short and blunt; the clypeogenal suture marked by a deep, rounded notch at the sides of the head; upper surface rather closely covered with middle-sized punctures.

Thorax very transverse, the anterior angles greatly protruding, rather blunt; the sides regularly curved, the greatest breadth being in the middle. Posterior angles straight; base gently curved and very feebly margined in the middle. Thorax with a rather deep longitudinal sulcus on each side of the disc. Puncturation of the thorax sparse and rather feeble, bearing (as do the elytra) short yellow setæ, erect and feebly clavate at tip.

Elytra short and broad, with rounded sides; the lateral margin is made by the eighth elytral interstria, which is strongly carinate up to the apex of the elytra. Humeral angle acute and protruding forwards; interstriæ slightly convex, with two irregular rows of setigerous punctures. Striæ feeble, cateniform, straight. Epipleural carinæ distinct.

Pygidium horizontal, short and small, with a strong annular groove. Mesosternum rather long. Prosternum strongly excavated under the front angles. Anterior tibiæ truncate at apex, short and broad; posterior tibiæ greatly enlarged at the tip. Tarsal joints triangular.

This new species appears at first sight as nearer to *Canthochilum* Chap. than to *Bdelyrus* Har. but the structure of the elytra ranges it decidedly in this last genus. *B. bowditchi* n. sp. is quite different from *B. seminudus* Bates (from Costa Rica and Ecuador) by the puncturation, the shagreened upper surface and the quadridentate clypeus. *B. lagopus* Har. from Brazil, the genotype, is unknown to me but nothing in its description differentiates it from *B. seminudus*, which, by the way, Bates placed in *Aphengium*.

Onthocharis panamensis n. sp. (fig. 5, 6, 8)

Type: From Panama Canal Zone: Barro Colorado Island, K. W. Cooper. Museum of Comparative Zoölogy no. 23,695.

Paratype: A specimen from the same locality in my collection.

Length: 3.5 mm., breadth: 1.5 mm.

Body parallel, elongate, very shining, very convex, metallic green.

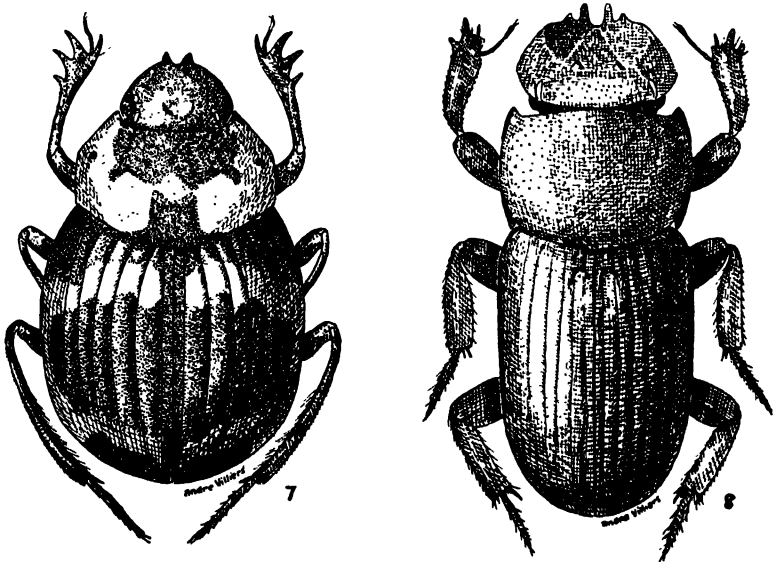

Fig. 7. *Canthon darlingtoni* n. sp.
Fig. 8. *Onthocharis panamensis* n. sp.

Head very broad, clypeus depressed in front, sex-dentate, the lateral teeth very short, broad and rounded; the median teeth long, slender, rounded at the apex. Part of the eyes visible from above very narrow. Vertex with two small, rounded tubercles. All the head covered with a sparse and rather strong puncturation.

Thorax very convex, parallel-sided in the first four-fifths, slightly sinuate behind; posterior angles strongly protruding behind; base strongly emarginate inside the posterior angles, a strong oblique depression in front of this emargination; base gently and regularly rounded; disc of thorax with a short median longitudinal sulcus on the posterior half, this sulcus not touching the base; front angles acute; puncturation rather strong and sparse.

Elytra parallel, with a feeble scutellar impression, interstriæ slightly convex, very feebly and sparsely punctured; striæ rather strong, not closely punctured. Pygidium very convex and shining, rather long, strongly margined, the margin slightly angular in the middle, sparsely and finely punctured.

Front tibiæ broad, smooth, tridentate externally, the apical tooth in line with the lateral margin of the tibiæ. Posterior and median tibiæ compressed, parallel, broad. Posterior tarsi with the first joint nearly as long as the two following taken together, cylindrical. Abdomen nearly smooth. Prosternum with a long, transverse, slightly oblique carina; the front angles slightly excavated.

This new and very small species is quite distinct from the known species of the genus (and I have had the opportunity of studying in London the types of Westwood and Waterhouse) by the length of the tarsal joints and their cylindrical form. A general revision of the genus is much needed as many unidentified, and probably new, species are to be found in many collections and museums.

METAMORPHOSES OF CUBAN HESPERIINÆ

By V. G. Dethier

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Introduction

As is generally the case when the life histories of skippers are studied, members of the subfamily Pyrginæ receive most attention while the Hesperiinæ are almost totally neglected. This situation is difficult to understand for though larvæ of the Pyrginæ are admittedly more spectacular and more frequently encountered in the field, a satisfactory treatment of their life histories is rendered difficult by several factors not the least of which is the fact that gravid females do not readily oviposit in captivity. Again, in many instances the food plant is unknown. On the other hand, Hesperiinæ oviposit on the least provocation, and the larvæ can be reared practically upon any grass. It is all the more surprising that the metamorphoses of Cuban Hesperiinæ have suffered neglect since all species can undoubtedly feed on sugar cane. Those species treated in this paper readily did so and the Hesperiinæ include not a few potential sugar cane pests.

Of the twenty-two species listed in this subfamily by Bates (1935) the life histories of but half are now known. Species which also occur in the United States have been studied by workers there. Gundlach (1881) recorded two additional species, and six species are treated below.

This work was made possible by my receiving a Harvard University Fellowship to study at the Atkins Institution of the Arnold Arboretum at Soledad, Cuba. The incompleteness of some of the life histories is due in part to the limited time available for study in Cuba. Color descriptions are based on a comparison with Ridgway's (1920) color charts.

It is a pleasure to acknowledge the generosity of Professor Thomas Barbour and the cheerful assistance of Mr. Frank Walsingham.

Polites baracoa (Lucas)

Egg.

Height .5 mm. Greatest diameter .7 mm. Yellow when laid, later becomes flesh color due to the appearance of blood red coloring in the fine raised reticulation present over the surface of the egg.

First Instar.

Head height .4 mm.; head width .37 mm. Head deep piceous. Shallowly punctate. Shield same color. Length of body 1.5 mm. Body yellow at emergence; after eating, tinged with grass green. Clothed with short distinctly clavate hairs. Anal segment with two pairs of long forwardly recurved hairs and a shorter pair of backwardly decurved hairs. Spiracles very faint fuscous. Legs fuscous.

Second Instar.

Head height .7 mm.; head width .6 mm. Head lighter piceous than before, with more numerous short colorless hairs. Head roughly punctate. In some specimens there are light areas in the regions of the epicranial and adfrontal sutures. Body length 2.4 to 4 mm. Body light green covered with many short colorless to brown hairs. Anal plate gray.

Third Instar.

Head height .9 mm.; head width .85 mm. Head roughly punctate. Slight evidence of light areas characteristic of later instars (cf. Fig. 10). Length of body 5.5 mm. Green dorsally, yellow laterally and ventrally. Covered with numerous short black hairs. Anterior two thirds of anal plate gray with a roughly spherical light area on either side of the median line. Posterior third of anal plate a much lighter gray.

Fourth Instar.

Head height 1.1 mm.; head width 1.1 mm. Head coarsely shagreened. Characteristic piceous design on a very light fuscous background (Fig. 10). Margin of foramen magnum piceous. Body length 6.5 to 8 mm. Mid-dorsal line dull green. Paradorsal lines mottled with light and dark green. Intersegmental areas brownish. Spiracles light cream. Short hairs covering body arising from small black warts. Dark

gray area of anal plate of greater extent. Light spots more elongate.

Fifth Instar.

Head height 1.4 mm.; head width 1.5 mm. Piceous design reduced in area. Ground color Old Gold except for a white band on either side of the epicranial suture and a white spot in the region of the ocelli. Rim of foramen magnum black. Body length 10 mm. Narrow irregular mid-dorsal line Argus Brown. Lateral line same but wider. Body Vinaceous-Buff, lighter on borders of lateral line and spotted with few irregular spots of Argus Brown. Stigmatal line a faint suggestion of darker background. Areas between dorsal line and lateral line more heavily spotted than elsewhere. Scattered colorless hairs over body. Spiracles cream. Black and white design on anal plate as in Fig. 4.

Eggs laid May 10 and 11 hatched May 17 seven days having elapsed. Moulting into the second instar took place on May 22 the first instar being of five days' duration. The second instar was of four to five days' duration moulting having occurred May 26. The third instar consumed five days with moults May 31. The fourth and fifth instars likewise were of five days' duration each.

Catia misera (Lucas)

Egg.

Height .75 mm. Greatest diameter .82 mm. Egg white, covered with a raised reticulation forming polygonal areas as is usual with the eggs of Hesperiinæ.

First Instar.

Head height .5 mm.; head width .45 mm. Head black, shiny, very faintly punctate. Few very small whitish hairs. Body length 2 to 3.8 mm. Body light Vinaceous-Buff spotted evenly with Fawn Color spots, more distinct on the posterior segments. Becomes slightly grass green especially at the anterior end after eating. Few scattered hairs on body bulbous at tip. Two pairs of long forwardly recurved hairs on anal segment. Also a pair of shorter backwardly decurved hairs. Claws of first pair of legs slightly fuscous.

Second Instar.

Head height .72 mm.; head width .70 mm. Head shiny black with faintly raised reticulations also shiny. Thoracic legs fuscous. Length of body 4.5 to 5 mm. Body dull grass green thickly mottled with maroon and white. Dull greenish mid-dorsal line. Under side of body dull greenish. Bright orange spot on each segment, segments one and two excepted, at stigmatal line. Short hairs covering body. Those on anal plate longer.

Third Instar.

Head height .8 mm.; head width .78 mm. Head roughly shagreened. Characteristic black and white design of head with greater percentage of black than in following instars (cf. Fig. 13), that is, white bands not so broad. Body length 5 to 7 mm. Body mottled white and dark ferruginous on dull background. Orange spots same as above. Many short black hairs from black tubercles. Legs fuscous.

Fourth Instar.

Head height 1.2 mm.; head width 1.0 mm. Head design as in Fig. 13. Body length 7 to 10 mm. Not much change from previous instar, general effect darker.

The egg stage lasted from seven to ten days. Eggs laid May 6, 7, and 8 hatched May 16; those laid May 9 to 11 hatched May 18; those laid May 19 and 20 hatched May 26 and 29. The first instar was of five to six days' duration with moults occurring in the above three groups May 23, 23, and 31 respectively. The second instar was of four to eight days' duration. The third and fourth instars were of seven days' duration each.

Poanes radians (Lucas)

Egg.

Height .5 mm.; greatest diameter .75 mm. Pearl white when laid. Later acquires a bright pink design which consists of an irregular circumpolar band and a slightly wider irregular equatorial band. The usual reticulation is present.

First Instar.

Head height .5 mm.; head width .52 mm. Head shiny black, faintly pitted. Body length 2 to 3.5 mm. Claws of

thoracic legs fuscous. Body light Baryta yellow; light green after eating. Two pairs of long forwardly recurved hairs of approximately equal length on anal segment.

Second Instar.

Head height .72 mm.; head width .7 mm. Head dull black, raised reticulations darker than ground work. Lighter in region of epicranial suture. Length of body 4.5 mm. Body yellow green covered with minute black hairs. Dorsal line slightly darker green. A conspicuous black stellate spot on each side of the median line of the anal plate.

Third Instar.

Head height .87 mm.; head width .8 mm. Characteristic brown to piceous head design on yellowish background (cf. Figs. 7 and 9) first appears in this instar. Areas bordering the epicranial and adfrontal sutures are white. Body length 5.5 to 9 mm. Body grass green with many short black hairs. Dull green mid-dorsal line. Spots on anal segment now usually four (Fig. 1).

Fourth Instar.

Head height 1.25 mm.; head width 1.10 mm. Head as in Figs. 7 and 9. Body length 9.5 mm. Similar to foregoing instar.

Eggs laid May 6 to 8 emerged May 13, five to seven days having elapsed. The first instar consumed six days moulting having occurred May 19 and 20. The second instar was of five to twelve days' duration with moulting May 31. The third and fourth instars required ten days each.

Lerodea tripuncta (Herrich-Schäffer)

Fourth Instar.

Head height 1.5 mm.; head width 1.35 mm. Head with a rough raised reticulation and the same characteristic fuscous design on whitish background as in the following instar. Body light green covered with short whitish to brownish hairs.

Fifth Instar.

Head height 1.9 mm.; head width 1.5 mm. Head as in

Fig. 5. Roughly shagreened and covered with many short white hairs. Body length 22 mm. Light green.

Chrysalis.

Length 18 mm. Narrow and generally cylindrical in shape. Anterior end acute. Cremaster long and pointed. Tongue case same length as chrysalis but free from base of wing pads to end. Surface of chrysalis smooth. General color light green. Free portion of tongue case with slight pinkish tinge. Cremaster transparent and colorless at its tip.

Prior to emergence of the adult the dark color of the wings becomes visible as does also the brilliant red of the eyes. The duration of the chrysalis stage is eight days.

Prenes nero sylvicola (Herrich-Schäffer)

Egg.

Height .5 mm. Greatest diameter .75 mm. The eggs range in color from bone white to flesh. The surface is adorned with a raised reticulation forming polygonal cells.

First Instar.

Head height .5 mm.; head width .6 mm. Head piceous, shiny, punctate, and with few whitish hairs. Body length 2 to 4 mm. Yellow on emergence, light green after eating. Covered with a few short brown clavate hairs. Anal plate with two pairs of very short (for this position) recurved hairs.

Second Instar.

Head height .75 mm.; head width .6 mm. First appearance of characteristic head pattern (cf. Fig. 11). Head with raised reticulation and short brownish to colorless hairs. Ground color light yellowish to greenish. Length of body 4.5 mm. Body clear grass green with a dark green mid-dorsal line bordered by a narrow white line. Also thin white paradorsals. Body covered with minute black hairs.

Third Instar.

Head height .9 mm.; head width .9 mm. Dark areas of head pattern more extensive than in following instar (Fig. 11). Minute black hairs covering head. Length of body 6

to 13 mm. Design as in previous instar but more pronounced. Faint indication of a white substigmatal line.

Fourth Instar.

Head height 1.6 mm.; head width 1.5 mm. Head as in Fig. 6. Body length 15 mm. Similar to previous instar.

Eggs laid May 11 to 13 emerged May 15 and 16 three to five days having elapsed. The first instar consumed from four to eight days with moults May 19 and 23. The second instar required five days with moults May 28. The third instar was of four days' duration.

Prenes nyctelius coscinia (Herrich-Schäffer)

Second Instar.

Head height 1.6 mm.; head width 1.5 mm. Head with raised reticulations and the characteristic design seen in all the following instars (cf. Fig. 8). Body green covered with minute brown hairs.

Third Instar.

Head height 2.1 mm.; head width 2.0 mm. Roughly punctate, otherwise similar to previous instar. Body length 12 mm. Body covered with many short black hairs. First four segments Sorrento Green. Remainder of body Opaline Green. Stigmatal line Opaline Green.

Fourth Instar.

Head height 2.6 mm.; head width 2.5 mm. Similar to previous instar. Body length 18 to 20 mm. Same as above.

Fifth Instar.

Head height 3.2 mm.; head width 3.0 mm. Head roughly punctate. Design as in Fig. 8. Dark areas fuscous; light areas Reed Yellow. Body length 25 to 28 mm. Body Water Green.

Chrysalis.

Length 21 mm. Covered with short brown hairs except on head and dorsal areas where the hairs are considerably longer, those on head being the longest. Tongue case reaches only to sixth abdominal segment. It is free only at the last

segment. Cremaster short and blunt. General ground color dead grass yellow. Eyes, mouthparts, cremaster, and tip of tongue case light brown. Two brown spots on pronotum.

When about to pupate the mature larva becomes dead grass yellow and spins a loose cocoon in the grass. Larvæ which pupated May 18 emerged May 27 nine days having elapsed.

CLASSIFICATION

Although the extent of our knowledge of larval Hesperiinæ in Cuba does not yet permit of a workable key to the different species, it already holds more than fair promise for one at a later date.

All of the forms now described may be identified by the characteristic head pattern or the color of the head of the later instars. For this the moulted head capsule is adequate.

It will be found that the larvæ may be divided into two groups, those with a color pattern on the head and those without. The patterns are sufficiently constant within the species to enable one to separate them by referring to Plate IX. *Polites baracoa* and *Poanes radians* may further be identified by the color pattern on the anal plate. *Catia misera* is characterized by dark ferruginous mottling. In this respect it closely resembles *Catia otho*. Two species are known in which the head lacks any definite pattern. One, *Calpodes ethlius*, may be distinguished by its dark orange head; *Hylephila phyleus*, the other, by its dark brown to black head.

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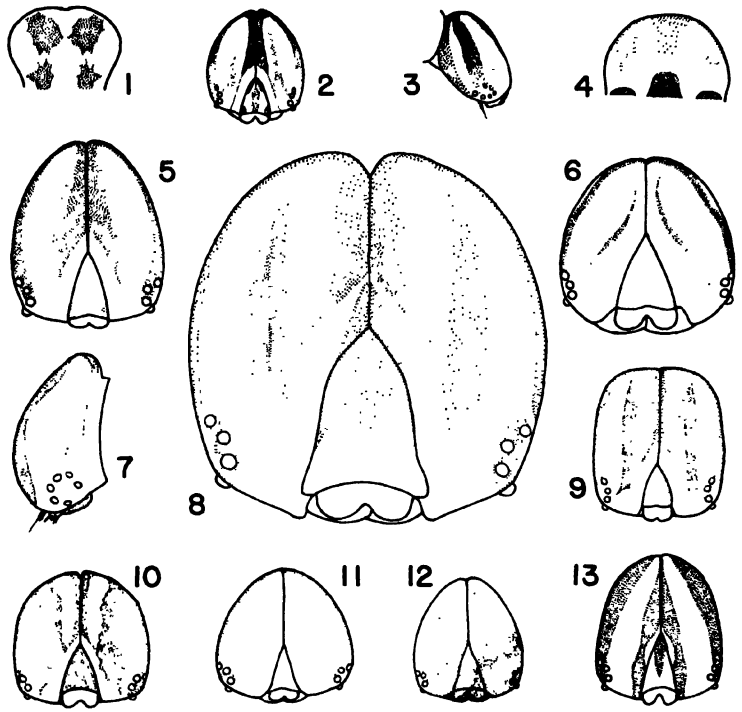

Fig. 1. Color pattern on the dorsal side of the anal segment of *Poanes radians* (Lucas).
Fig. 2. Front view of the head of *Lerodea eufala* (Edwards).
Fig. 3. Lateral view of the same.
Fig. 4. Color pattern on the dorsal side of the anal segment of *Polites baracoa* (Lucas).
Fig. 5. Front view of the head of *Lerodea tripuncta* (Herrich-Schäffer). Last instar.
Fig. 6. Front view of the head of *Prenes nero sylvicola* (Herrich-Schäffer). Fourth instar.
Fig. 7. Lateral view of the head of *Poanes radians* (Lucas). Fourth instar.
Fig. 8. Front view of the head of *Prenes nyctelius coscinia* (Herrich-Schäffer). Last instar.
Fig. 9. Front view of the head of *Poanes radians* (Lucas). Fourth instar.
Fig. 10. Front view of the head of *Polites baracoa* (Lucas). Fourth instar.
Fig. 11. Front view of the head of *Prenes nero sylvicola* (Herrich-Schäffer). Third instar.
Fig. 12. Front view of the head of *Hylephila phyleus* (Drury).
Fig. 13. Front view of the head of *Catia misera* (Lucas). Fourth instar.

NEW WEST INDIAN BUPRESTID BEETLES

By W. S. Fisher

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This paper is the result of a study of the beetles of the family Buprestidæ from the West Indies, sent to me for identification from the Museum of Comparative Zoölogy, Cambridge, Mass., by Dr. P. J. Darlington, Jr. All the new species described in this paper were collected by Dr. Darlington on his numerous trips to these islands.

Paratyndaris antillarum, new species

Short, robust, subcylindrical, rather strongly shining; body above and beneath piceous, with distinct purplish and greenish reflections in different lights.

Head feebly, uniformly convex, without a median depression; surface rather densely, coarsely, uniformly punctate, with a few very short, inconspicuous hairs, the intervals smooth; clypeus broadly, rather deeply, arcuately emarginate in front; antennæ missing.

Pronotum strongly, uniformly convex, one-third wider than long, distinctly narrower at apex than at base, widest at middle; sides strongly arcuately rounded; lateral margin, when viewed from the side, entire, and slightly arcuate; anterior margin truncate; base vaguely, transversely sinuate; disk without depressions or smooth lines; surface finely, transversely striolate, and asperate at middle, coarsely, rather densely punctate, and more or less rugose toward the sides, sparsely clothed with short, inconspicuous hairs. Scutellum glabrous, elongate-triangular.

Elytra as wide as pronotum at base; sides nearly parallel from humeral angles to behind middle (feebly constricted along basal fourth), then arcuately converging to the tips, which are separately broadly rounded, with a distinctly ele-

vated, sinuate, preapical carina; lateral margins coarsely, irregularly serrate; disk uneven, and each elytron with a transverse depression along base, an oblique depression in front of middle, and a feeble, median gibbosity at apical third; surface irregularly striate, coarsely, irregularly punctate, more densely basally, and sparsely, irregularly clothed with moderately long, recumbent, whitish hairs.

Abdomen beneath coarsely, rather sparsely, uniformly punctate, sparsely clothed with very short, inconspicuous hairs; second sternite with the posterior margin truncate, without a distinct plate extending over the third sternite; last visible sternite terminating in an acute spine.

Length 7 mm., width 3 mm.

Type locality.— South side of Lake Enriquillo, Dominican Republic.

Type.— In the Museum of Comparative Zoölogy, Cambridge, Mass. Type no. 23,696. Paratype in the United States National Museum.

Described from two specimens (one type) found dead at the type locality during September 1938 by P. J. Darlington, Jr.

The type is probably a female but has not been dissected. Both specimens are more or less broken and the head is missing from the paratype. The paratype has a very small plate at posterior margin of second sternite.

This is the first species of *Paratyndaris* to be recorded from the West Indies. It resembles *P. acaciæ* Knull, but differs from that species in being shorter and more robust, in having the elytra uneven, uniform in color, and the lateral margin without two distinct teeth near apex, the second sternite without or with only a feebly indicated plate at the posterior margin, and in not having the pronotum sulcate at the middle.

Buprestis hispaniolæ new species

Female.— Broadly elongate, moderately convex above, strongly shining; pronotum brownish cupreous, with a more or less distinct greenish reflection, and ornamented with reddish yellow as follows: A rather broad vitta on each side along lateral margin extending from apical angle to near

posterior angle, a narrow fascia on each side on anterior margin, three round spots along base, and a rounded spot at middle near anterior margin; elytra purplish brown, each elytron with two broad, irregular, reddish-yellow vittæ, the lateral one extending from humeral angle to near apex, and the sutural one from near base to apical fifth; body beneath brownish cupreous, with the prosternum, median parts of metasternum and mesosternum, femora in part, and transverse fasciæ on the sternites, reddish yellow.

Head nearly flat, purplish brown, with a transverse yellow spot on each side at vertex and several irregular yellow spots behind the clypeus, and with a short carina on the front; surface coarsely, irregularly, confluently punctate, sparsely clothed with short, erect, inconspicuous hairs; eyes feebly converging above; clypeus broadly, arcuately emarginate in front.

Pronotum twice as wide as long, distinctly narrower at apex than at base, widest near base; sides sinuate and strongly, obliquely diverging from apical angles to near posterior angles, which are broadly rounded; anterior margin broadly, arcuately emarginate, with the median lobe broadly, feebly rounded; base transversely sinuate; surface slightly uneven, coarsely, deeply, irregularly punctate, with a few short, inconspicuous hairs at posterior angles, the intervals smooth. Scutellum quadrate, truncate in front, broadly rounded behind.

Elytra slightly wider than base of pronotum; sides feebly expanded behind the humeri, feebly converging to apical third, then strongly, arcuately converging to the tips, which are separately transversely truncate, with a small tooth at each angle; surface striato-punctate, the striæ not deeply impressed, the punctures fine and closely placed in the striæ; intervals feebly convex, coarsely, irregularly punctate, and the intervals toward the sides more or less rugose.

Abdomen beneath coarsely, irregularly punctate, sparsely clothed with short, semierect, white hairs, the intervals obsoletely granulose; first sternite longitudinally flattened at middle; last visible sternite sinuately rounded at apex. Prosternum coarsely, sparsely punctate, sparsely clothed with short, recumbent, whitish hairs; prosternal process

flattened at middle, obliquely expanded from anterior coxal cavities to the apex, which is acute.

Length 18-20 mm., width 7-7.5 mm.

Male.— Unknown.

Type locality.— Between Constanza and Jarabacoa, at an altitude of 2,000 to 4,000 feet, Dominican Republic.

Type.— In the Museum of Comparative Zoölogy, Cambridge, Mass. Type no. 23,697. Paratype in the United States National Museum.

Described from two females (one type) both collected by P. J. Darlington, Jr. The type was collected at the type locality during August 1938, and the paratype was collected in the foothills of the Cordillera Central, south of Santiago, Dominican Republic, during June 1938.

This species resembles *Buprestis lineata* F., but it differs from that species in having the pronotum and underside of body ornamented with reddish-yellow spots. The reddish-yellow spots on the underside of the body in the two specimens examined are more or less variable in shape.

Peronæmis insulicola, new species

Male.— Rather narrowly agriliform, rounded in front, more acuminate behind, glabrous, rather strongly shining; head bluish green in front, becoming violaceous on occiput; pronotum dark green, with a more or less distinct violaceous tinge on certain parts; elytra dark violaceous green, bronzy green along sutural margins; body beneath green, with a golden reflection on abdomen, more strongly shining than above, and the legs in part bluish green.

Head nearly flat in front, with a vague, longitudinal carina on occiput; surface coarsely, deeply, densely, uniformly punctate, the intervals finely granulose; clypeus wide between the antennal cavities, feebly, transversely concave, broadly, shallowly, angularly emarginate in front.

Pronotum rather strongly convex, strongly deflexed at sides, one-third wider than long, slightly wider at base than at apex, widest at middle; sides feebly, arcuately rounded; anterior margin feebly sinuate, with a feeble, broadly rounded, median lobe; base nearly transversely truncate; lateral margin when viewed from the side sharply defined,

arcuate, extending from base to near apical angle; disk with three large, deep, basal depressions, the median one not extending to middle, with a deep fovea in front of scutellum, the lateral ones extending to middle of pronotum; surface coarsely, deeply, densely, uniformly punctate, the intervals finely, densely granulose. Scutellum twice as wide as long; sides feebly rounded; surface nearly smooth.

Elytra as wide as pronotum at base; sides broadly, angularly expanded behind humeral angles, nearly parallel to middle, then strongly, obliquely converging to the tips, which are acute; lateral margins coarsely, irregularly serrate; basal depressions rather deep and broadly transverse; surface irregularly striato-punctate, more or less rugose basally, the intervals finely, densely granulose, with a few coarse punctures intermixed.

Body beneath coarsely, rather densely, irregularly punctate, finely granulose, sparsely clothed with moderately long, erect, inconspicuous hairs; last visible sternite feebly, arcuately emarginate at apex.

Length 10 mm., width 3.25 mm.

Female.— Unknown.

Type locality.— Between Constanza and Jarabacoa, at an altitude of 2,000 to 4,000 feet, Dominican Republic.

Type.— In the Museum of Comparative Zoölogy, Cambridge, Mass. Type no. 23,698.

Described from a unique male collected at the type locality during August 1938 by P. J. Darlington, Jr.

This species is allied to *Peronæmis monticola* Fisher, but it differs from that species in being of a more uniform color above, in having the pronotum rounded at the sides, the elytra strongly angulated behind the humeral angles, and in not having a finely punctured vitta along the sutural margins of the elytra.

Enbrachys gibbipennis, new species

Male.— Ovate, nearly twice as long as wide, broadly rounded in front, more attenuate posteriorly, strongly shining, glabrous; head and pronotum green, more or less bronzy, the latter with the elevated median part piceous; elytra uniformly piceous; body beneath piceous, with an indistinct purplish tinge.

Head moderately convex, broadly, longitudinally depressed in front, with a narrow, longitudinal groove extending from clypeus to middle of front, deeply, narrowly, transversely depressed behind clypeus, with three deep foveæ in the depression, one median and two lateral; surface densely, coarsely granulose, with numerous coarse, shallow punctures intermixed; antennal cavities nearly contiguous in front.

Pronotum nearly three times as wide as long at middle, considerably narrower at apex than at base, widest near base; sides parallel along basal third, then strongly, obliquely converging to the apical angles, which are acute; posterior angles subrectangular; when viewed from the side the lateral margin is straight anteriorly, arcuate near posterior angle for the reception of the anterior leg; anterior margin deeply, broadly, arcuately emarginate; base transversely sinuate on each side, the median lobe strongly produced, and broadly truncate in front of scutellum, disk with the anteromedian part strongly, transversely convex, narrowly flattened along base, and very broadly flattened and uneven at the sides; surface coarsely, sparsely punctate on convex median part, densely granulose, with a few coarse punctures intermixed on the flattened areas. Scutellum triangular, distinctly wider than long.

Elytra nearly as wide as pronotum at base; humeral angles broadly rounded; sides parallel from humeral angles to middle, then obliquely converging to the tips, which are conjointly broadly rounded; lateral margins feebly serrate; surface very uneven, coarsely, sparsely, shallowly, irregularly punctate, and each elytron with moderately elevated, broadly rounded gibbosities as follows: An oblique one on humerus, an elongate one along sutural margin behind scutellum, a rounded one near lateral margin just behind the middle, and an elongate one near apex.

Abdomen beneath vaguely granulose or reticulate, with a few shallow, inconspicuous punctures intermixed; last visible sternite broadly rounded at apex, the apical groove deep, and following outline of lateral margins. Prosternum feebly reticulate, sparsely, coarsely, shallowly punctate; prosternal process broad, the sides obliquely converging to the apex, which is broadly rounded.

Female.— Differs from the male in being uniformly piceous, with a more or less distinct cupreous reflection, and in having the last visible sternite more broadly subtruncate at apex.

Length 2.75 mm., width 1.5 mm.

Type locality.— Mt. Diego de Ocampo, at an altitude of 3,000 to 4,000 feet, Dominican Republic.

Type and allotype.— In the Museum of Comparative Zoölogy, Cambridge, Mass. Type no. 23,699. Paratypes in the United States National Museum.

Described from four specimens, two males and two females (one male type), all collected at the type locality during July 1938 by P. J. Darlington, Jr.

This species resembles *Enbrachys otero* Fisher, from which it differs in having the front of the head more shallowly depressed, the sides of the pronotum more strongly flattened, and in not having the gibbosities on the elytra so abruptly elevated.

Leiopleura darlingtoni, new species

Oblong, rather strongly convex above, broadly rounded in front, more strongly narrowed posteriorly; head yellowish cupreous; pronotum reddish cupreous on convex median part, bronzy green on flattened area at sides; scutellum bright blue; elytra opaque olivaceous green, with a quadrate, opaque, blue spot behind the scutellum, a large, shining, piceous area on each side along lateral margin behind humerus, and a similar area in front of scutellum, common to both elytra; body beneath black, with a faint purplish reflection, and strongly shining.

Head strongly, uniformly convex, with four deep, round foveæ behind the clypeus; surface densely, coarsely reticulate, with a few shallow, indistinct punctures intermixed; antennæ uniformly piceous, nearly contiguous at bases.

Pronotum twice as wide as long, distinctly narrower at apex than at base, widest along basal half, strongly, uniformly convex on antero-median part, strongly flattened along base and on each side along lateral margin; sides strongly, arcuately diverging from apical angles to middle, then parallel to the posterior angles; anterior margin subtruncate; base transversely sinuate on each side, the median

lobe feebly produced and broadly truncate in front of scutellum, surface coarsely, densely reticulate, with a few shallow, inconspicuous punctures intermixed. Scutellum triangular, nearly twice as wide as long, densely granulose, the granules flattened on top, resembling round, microscopic scales.

Elytra slightly wider than base of pronotum, rather strongly convex, broadly depressed along lateral margins behind humeri; humeral angles obtusely rounded; sides parallel and feebly sinuate from humeral angles to middle, then arcuately converging to the tips, which are conjointly broadly rounded, the lateral margins not distinctly serrate; humeri strongly elevated; surface densely granulose and sparsely, coarsely punctate on the olivaceous-green and bright-blue areas, the granules similar to those on the scutellum, and sparsely, coarsely punctate on the shining piceous areas.

Abdomen beneath densely, obsoletely reticulate, with a few inconspicuous punctures intermixed; last visible sternite broadly rounded at apex. Prosternum obsoletely reticulate, with a few coarse punctures intermixed, the groove for the insertion of the antenna short and shallow. Metasternum shallowly emarginate in front.

Length 2 mm., width 0.8 mm.

Type locality.— Labeled "R. Froide, Port-au-Prince, Haiti."

Type.— In the Museum of Comparative Zoölogy, Cambridge, Mass. Type no. 23,700.

Described from a single specimen collected at the type locality October 3, 1934, by P. J. Darlington, Jr., to whom I take great pleasure in dedicating the species.

This species differs from all the known species of *Leiopleura* in having the peculiar scale-like sculpture on the elytra and scutellum.

Micrasta puertoricensis, new species

Male.— Oblong oval, equally rounded in front and behind, moderately shining, glabrous; uniformly black, with an indistinct bronzy tinge above; body beneath black, with a faint purplish reflection, the tarsi yellowish, with the tarsal lamellæ whitish.

Head feebly convex, when viewed from above forming a

regular arc with the pronotum; surface densely alutaceous, sparsely, coarsely, shallowly punctate; front with the sides parallel; clypeus not transversely depressed, feebly constricted between the antennal cavities, feebly, broadly emarginate in front. Antenna extending beyond base of pronotum, sparsely clothed with long, erect, whitish hairs; first and second segments globuse, subequal in length; third distinctly narrower, feebly expanded at middle, subequal in length to the second; the following segments rather robust, subequal in length, slightly triangular, the last segment longer than the tenth, and acute at apex.

Pronotum strongly, uniformly convex, feebly, transversely flattened along base, twice as wide as long, distinctly narrower at apex than at base, widest behind middle; sides strongly, arcuately converging anteriorly, slightly converging near posterior angles; when viewed from the side the marginal and submarginal carinæ feebly arcuate, widely separated for nearly their entire length, and united at base, the marginal carina more or less obsolete anteriorly; anterior margin feebly, arcuately emarginate; base transversely truncate; surface feebly alutaceous, sparsely, coarsely, shallowly punctate. Scutellum triangular, acute at apex.

Elytra as wide as pronotum at base; sides parallel from humeral angles to apical third, then arcuately converging to the tips, which are conjointly broadly rounded; humeri not prominent; disk uniformly convex, with a shallow, transverse depression at base of each elytron; surface feebly, sparsely punctate, the intervals nearly smooth.

Abdomen beneath feebly convex, feebly reticulate, vaguely punctate, clothed with a few short, erect, inconspicuous hairs; basal sternite with a round, median depression, which is densely clothed with long, erect hairs; last visible sternite broadly rounded at apex. Prosternum moderately convex, coarsely, sparsely punctate; anterior margin subtruncate; prosternal process broad, the sides parallel, and broadly truncate at apex. Femora moderately robust. Tibiæ straight and slender.

Length 1.25 mm., width 0.6 mm.

Type locality.— Maricao Forest, at an altitude of 2,000 to 3,000 feet, Puerto Rico.

Type.— In the Museum of Comparative Zoölogy, Cambridge, Mass. Type no. 23,701. Paratype in the United States National Museum.

Described from two males (one type) collected at the type locality between May 30 and June 2, 1938, by P. J. Darlington, Jr.

This species resembles *Micrasta oakleyi* Fisher, but differs from that species in being uniformly black with an indistinct bronzy-green tinge, in having the marginal carina on the pronotum more or less obsolete anteriorly, the pronotum feebly, transversely depressed along the base, the scutellum acute at the apex, the surface of the elytra more feebly punctured, and in not having the clypeus transversely depressed.

Micrasta subcylindrica, new species

Female.— Differs from *Micrasta puertoricensis* Fisher as follows: Elongate, subcylindrical, and strongly convex above, strongly shining, piceous; pronotum more coarsely punctured, widest at middle, with the sides arcuately rounded; head coarsely, sparsely punctate, feebly, longitudinally depressed at middle; scutellum longer than wide, acute at apex; each elytron with a broad, triangular depression at base; abdomen and prosternum coarsely, densely punctate, the basal sternite without a round, median depression clothed with long hairs (this is a male sexual character); and the tarsi and apical halves of tibiæ yellowish.

Length 2 mm., width 0.75 mm.

Type locality.— Soledad (Cienfuegos), Cuba.

Type.— In the Museum of Comparative Zoölogy, Cambridge, Mass. Type no. 23,702.

Described from a unique female collected during May 1936 by P. J. Darlington, Jr.

Micrasta monticola, new species

Male.— Differs from *Micrasta puertoricensis* Fisher in being more robust, more strongly convex above, strongly shining, uniformly bronzy brown, and in having the pronotum and elytra coarsely, rather densely punctate, with the intervals smooth, pronotum widest along basal half, with the sides nearly parallel posteriorly, scutellum longer than

wide, and acute at apex, elytra with the sides parallel from humeral angles to middle, and each elytron with a distinct, rather broad, transverse groove at base, the last visible sternite broadly rounded at apex, and in having the intermediate sternites narrowly, transversely grooved at the middle.

Length 2 mm., width 1 mm.

Type locality.— Mt. Diego de Ocampo, at an altitude of 3,000 to 4,000 feet, Dominican Republic.

Type.— In the Museum of Comparative Zoölogy, Cambridge, Mass. Type no. 23,703.

Described from a unique male collected during July 1938 by P. J. Darlington, Jr.

Micrasta hispaniolæ, new species

Female.— Differs from *Micrasta monticola* Fisher in being uniformly bluish black, subopaque, in having the pronotum widest at the middle, with the sides arcuately converging posteriorly, and the surface rather densely, coarsely punctate, with the intervals distinctly alutaceous, and in having the sides of the elytra parallel from humeral angles to apical third. It also resembles *Micrasta puertoricensis* Fisher, but it differs from that species in being more robust, more strongly convex above, subopaque, in having the pronotum and elytra rather densely, coarsely punctate, with the intervals distinctly alutaceous, and in having a distinct, broad, transverse depression at the base of each elytron.

Length 2 mm., width 1 mm.

Type locality.— Foothills of the Cordillera Central, south of Santiago, Dominican Republic.

Type.— In the Museum of Comparative Zoölogy, Cambridge, Mass. Type no. 23,704.

Described from a unique female collected during June 1938 by P. J. Darlington, Jr.

It is just possible that this may be the female of *monticola* Fisher, but on account of the differences given and without additional notes on their habits it seems advisable to consider them to be two distinct species. There does not seem to be a good series of any of the described species of this genus available for study, so it is impossible to decide what variation occurs in the species.

CONCERNING CHLOROPERLA (PERLIDÆ)

By Nathan Banks

Museum of Comparative Zoology.

Recently there has been discussion by Frison and Ricker, the latter quoting Claassen, as to whether this name should replace Alloperla. When I made the Classification of the Perlidae in 1906, I had no European collection, and there was then no literature on the European forms of prime value. So I accepted Hagen's use of Isopteryx based on the lack of a folded anal area to the hind wing which is true for our form that he identified as *cydippe* Newm. I showed that the genus Chloroperla should replace Isopteryx. Since then I have not treated this group, but others have. Enderlein in 1909 applied my classification to the European and exotic forms known to him. Seeing that some of the European species had a small anal area, he wisely used another and more definite character, the fact that the second anal vein of the fore wings is unbranched in all the species, except *I. serricornis*, for which he made a new genus, Isoptena.

In 1912 Okamoto in his revision of the Japanese Plecoptera also uses this unforked second anal as the character of Chloroperla. In 1936 Kimmins reviewed the facts concerning Chloroperla and Isopteryx and agreed with me that the latter is a synonym of the former. He lists three species of Chloroperla in the British fauna, *torrentium, tripunctata,* and *apicalis*. The first two have a small anal area to hind wings, the third lacks it. So Kimmins evidently is using the unforked second anal as the generic character. But Needham, Claassen, Frison, and Ricker seem unaware that the unforked second anal has ever been used as the generic character, although they list Enderlein's paper in their bibliographies. Moreover, Needham and Claassen in their description of Chloroperla state that the second anal is branched, and put it under this heading in their synoptic table; however, their figure on Plate 14 shows the second

anal unbranched. It was doubtless this mistake that led Ricker to describe his Hastaperla. Using the unbranched second anal vein as the generic character, our species (*brevis*) belongs to Chloroperla as truly as *apicalis* and *tripunctata*.

In 1912 when I saw the type of *C. cydippe* Newm. I noted it had a small anal area with one longitudinal vein; recently Ricker has seen it and says the second anal is forked, so this species is doubtless an Alloperla.

Kimmins considers that the genotype of Chloroperla (*lutea* Latr. is a synonym of *tripunctata*. I cannot agree. Latreille says of *lutea*, "extrémité des antennes noires"; and Newman says of *apicalis*, "extreme portions of the antennæ intensely black". Neither mention any black border to the pronotum.

Scopoli does not mention antennæ in his description of *tripunctata*, which, he says, agrees except in some points with *grammatica*. Of *grammatica* he says, "antennæ basi flavæ, extrorsum fuscæ". Klapalek in Süsswasserfauna Deutschlands (1909) says for *tripunctata* that the basal third of the antennæ is yellow, rest black, and that the pronotum is bordered with a black line.

In specimens here (Hagen coll.) *tripunctata* has mostly brown to black antennæ except basal third or less, while in *apicalis* (even specimens at least 90 years old) there is a greater part yellow and beyond "intensely black". Since *lutea* agrees with *apicalis* in both antennæ and pronotum and in neither with *tripunctata*, it is evident that *lutea* Latr. will replace *apicalis*. In either case *brevis* belongs to Chloroperla, and Chloroperla is distinct from Alloperla.

PSYCHE

INDEX TO VOL. XLVI, 1939

INDEX TO AUTHORS

INDEX TO SUBJECTS

All new genera, new species and new names are printed in SMALL CAPITAL LETTERS.